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The Denatured Alcohol Situation.

In the last issue of The Engineering Record the Department of Agriculture's recent tests of gasoline engines with alcohol as fuel were briefly described. In spite of the denatured alcohol law and the interest it excited, the results up to date have been inconsiderable so far as fuel uses are concerned. It is somewhat unfortunate that wood alcohol remains still the chief material used in the denaturing process, since when used in so large a proportion as 10 per cent. it is a considerable item of expense, while the pyridin bases employed if the amount of wood alcohol is reduced are not produced in material amount in this part of the world. This rather complicates the situation if one attempts to get alcohol from the cheapest present source, i. e., the refuse of cane sugar production. In the sugar producing countries alcohol can undoubtedly be made at a figure which would permit its importation and denaturing at a price which would put it into immediate competition with gasoline. It is therefore much to be desired that a more convenient and cheaper process for denaturing should be authorized if one can be found.

As regards the results obtained with alcohol in gasoline engines, they are upon the whole very encouraging. Of course there is no getting around the fact that gasoline has a higher thermal value than alcohol, gallon for gallon, in the ratio of nearly 3 to 2. Obviously alcohol must be obtainable at about two-thirds the price of gasoline to put it in full competition merely on the basis of fuel cost. With gasoline at the prices now current in this country such competition in the gross, as it were, is for the present unlikely. But nevertheless the use of alcohol should be encouraged as an automatic check on increase of price in gasoline. This substance being practically in the hands of a monopoly such a check is exceedingly important, lest the price should suddenly be put up, let us say to the much higher figure prevalent abroad. As regards net value for the purposes of its use, alcohol has a much better situation, especially as regards its employment in automobile engines. The gain in its use is two-fold; first, it gives somewhat greater power in an engine of given size; and, second, it burns far more cleanly. As regards the first count, one can therefore build a somewhat lighter and smaller engine for the same output. This is a distinct help for one of the prevalent vices in automobile design is excessive weight for the motive power carried. A heavy engine means heavy supports. Incidentally the lessened danger of auto ignition when using alcohol makes it easier to use air-cooled engines which still further lightens and simplifies the structure. Further the much cleaner combustion of alcohol lessens the danger of overheating and the chance of serious friction from the accumulation of soot in the cylinders. Gasoline is of complicated and variable composition and its tendency is to leave hard carbonaceous residues unless the combustion is exactly what it should be. And proper combustion in automobile operation is very difficult to maintain.

For these reasons there would seem to be a strong probability that the use of alcohol would tend to materially lessen repairs, an improvement which is very greatly to be desired. In spite of the fact that gasoline engines as now made can be used with alcohol the researches described last week make it pretty clear that some minor changes in carbureters and compression, and perhaps in ignition are desirable in an engine to be used exclusively with alcohol. It is to be hoped that some of the more enterprising automobile makers will take up the question and be prepared to furnish first class alcohol engines if desired. The gain in the abolition of the unpleasant odor of gasoline is a material one, too, especially in cities where many malodorous machines are now in use. If some of the large makers would thus take hold of the question and arrange to keep in stock denatured alcohol in the large centers, a considerable gain would be made. Even now Cuban alcohol could probably be denatured and imported at a figure that would not be at all prohibitive.

As regards the use of alcohol in ordinary stationary engines the possible gain is less. Such engines can be run under fairly uniform conditions of combustion, and a little extra weight is of small moment. With the introduction of small gas producers, too, giving less fuel cost even than gasoline, there will be a tendency to confine the use of stationary gasoline engines to very modest sizes so that they will become relatively less important. Still if the production of cheap alcohol once gets fairly under way there is a good chance that the price can be brought to a figure that will encourage its use, especially since in some parts of the country the transportation charges on gasoline are considerable, while alcohol may be of local manufacture. At all events the automobile side of the matter may easily rise to considerable importance, and it is earnestly to be hoped that the work will be rapidly pushed along.

Interpreting Power Plant Tests.

Whatever may be the object of a test of a commercial power plant, the interpretation of the results secured is unquestionably the most important part of the whole task. Too little emphasis has been laid in the past upon the analysis of test results, in comparison with the pains bestowed upon the test apparatus, its arrangement and readings. To secure consistent figures from a more or less complicated outfit of inter-related machinery during a service trial requires a high order of technical knowledge; but to dissect the detailed columns of test figures obtained in the field and marshal them in groups for or against a given policy in design, construction or operation, calls for the most experienced judgment of the trained engineer.

Without carefully obtained test data it is, of course, almost impossible to draw correct conclusions. No sensible engineer would minimize the need of accurate readings and full records of all unusual conditions arising during a test—and few tests are run off under commercial conditions without the presence of disturbing factors which a pure theorist would overlook in planning the work. To the outsider one day looks very much like another in a plant handling routine service, but the operating man inside the station walls realizes that even in such a uniform business as handling the morning and evening rush hour loads of a street railway system on two successive days in the same season of the year, contingencies and differences in hourly conditions are bound to keep him on the anxious seat until the peak load has been passed. Granting such points as this, however, does not for a moment lessen the responsibility of those who are to interpret the data secured.

The practice in some companies requires the testing engineer to submit comments upon his experiment data when presenting the figures to his executive officers. Such a course need not in any way vitiate the analysis of the figures which the higher officer may bring to bear, and in many cases it opens the way toward a much closer cooperation between the head of a department and his subordinates. It is easy for young engineers to fall into the error of assuming that everything needful has been done when a set of test data has been carefully tabulated. If heads of departments would more generally encourage the presentation of critical comments with their subordinates' test figures, even in minor investigations, there is no question that many valuable suggestions would thereby be placed on file, instead of overlooked or lost, as is too often the case. In matters like counting stores and checking up carload shipments figures speak for themselves; but in a power plant test a correct interpretation requires full knowledge of the conditions and arrangements obtaining at the time.

Among the sources of inaccurate deductions from test records are failure to separate different kinds of output in relation to the station load as a whole, omission of instrument, tank and scale calibrations, and consequent calculation of costs without reference to the accuracy of the readings, absence of calorific determinations upon representative fuel samples, neglect of atmospheric and weather conditions in studying the results of chimney and blower performance and failure to appreciate the load factors and efficiencies of individual machines contrasted with the station as a whole. In order to interpret the results of an extensive test on a large plant it is very desirable to know what similar equipment may be expected to do and what it has done in other installations; and if the plant which has been tested is to be modified in arrangement or operating methods the hours of service of each important unit need to be studied quite as carefully as the possible sources of energy loss in the chain of events between the coal bunker and the bus bar. The condition of the apparatus with regard to repairs and depreciation, its performance at different seasons of the year under varied load conditions, the number of men on the operating shifts and their personal equations all need to be considered before any sweeping change in station design or methods of handling is carried into effect. It is a great mistake to make a hasty decision to modify a plant's equipment in the light of a single test taken by itself without relation to daily records of service. If a test shows the existence of unfavorable conditions it is far better to endeavor to improve the economy of the existing installation then to tear out important parts of it on the strength of a single test interpretation. Sweeping changes are better the result of both tests and corroborative operating experience.

The British Machinists' Agreement.

Few things have occurred of late in the manufacturing world so instructive as the agreement recently signed between the Engineering Employers' Federation and the representatives of the three leading machinists' trade unions in Great Britain. The history of this agreement is worth consideration. For some time prior to 1897 there was a dispute between employers and employees in the machinery industries of Great Britain over the eight-hour day. The unions had been fairly well organized long before that date, and consequently the fight they put up could be readily directed by central authorities. On the other hand the employers were without any association for a considerable time. Each man was striving to enforce his own ideas in his own way and as a result there was a long-drawn-out struggle disastrous for the machinery trade of the country. During that time the United States and Germany obtained a large amount of business which would naturally have gone to Great Britain, and neither men nor employers gained materially by the strife. A national trade union fighting against dissociated manufacturers has always a great advantage. The struggle can be confined to those places where the conditions are most favorable to the union and work can be continued in places where the union has little to gain, so that funds for the strike can be contributed by the men of one district to those of another. Owing to this former lack of agreement among employers, shop rules and methods differed widely in different parts of the country, and in consequence the cost of production of the same kind of output varied widely. The disturbances prior to the strike of 1897 brought this fact home to the manufacturers very vividly, and as a result the Engineering Employers' Federation was formed, which in 1898 successfully demanded and enforced practically uniform conditions in all parts of the kingdom.

When the Federation and the unions drew up their first agreement nine years ago, there still remained a very bitter feeling on the part of some of the representatives of both sides of the warring interests. Since the representatives have become better acquainted in the course of their duties in settling differences of opinion between employers and employees, a very much better feeling has arisen. The old days of the influential blatherskite have largely passed away, and at the same time a tremendous pressure has been put upon the employer who says he will be hanged if he will allow anybody to dictate how he shall treat his men. The trade unions have sent their best men to represent them in conferences with employers, and the latter have sent tactful representatives to these meetings. Both sides have been the gainers in consequence, and there is now a feeling of mutual respect between the two parties, which is a favorable sign of industrial tranquility and a better appreciation of the obligations of all concerned in the engineering trade. This is well shown in the new agreement between the two parties.

Under the terms of this agreement the members of the Federation agree not to interfere with the proper functions of the union and the latter agree not to interfere with the employers in the management of their business. This is a sort of general statement which has definite meaning only in the light of the subsequent clauses of the agreement. These are important on account of their explicit nature. For example, it is specifically provided that every employer may employ any man, and every workman may take employment with any employer, whether the workmen or the employer belongs or not to a trade union or to the Federation respectively. Furthermore the trade unions recommend all their members not to object to work with non-union workmen, and the Federation recommends all its members not to object to employ union workmen on the ground that they are members of a trade union. Moreover, no workman will be required, as a condition of employment, to make a declaration as to whether he belongs to a trade union or not.

The old source of controversy over piece work seems to be pretty well eliminated by the terms of the agreement. Employers and their men are entitled to work piece work under certain conditions. The first of these is that the prices to be paid shall be fixed by mutual agreement between the employer and the men who perform the work. The second condition is that each workman's daily pay is to be guaranteed irrespectively of his piece work service. The third condition is that overtime and night shift allowances are to be paid in addition to piece work prices on the same conditions as already prevail in each workshop for time work. As regards overtime, both the Federation and the unions agree that systematic overtime is to be deprecated as a method of production and that when overtime is necessary the following conditions should be observed so far as possible. No union workmen shall be required to work more than 32 hours overtime in any four weeks after full shop hours have been worked, allowance being made for time lost through sickness, absence with leave, or enforced idleness. On the other hand the agreement specifically states that overtime ought not to be restricted in cases of breakdown, repairs, alterations for employers or their customers, trial trips and repairs to ships, and cases where urgency or emergency enter.

The rating with respect to pay is one of the most important features of the agreement. Under its terms employers have the right to employ men at rates of wages mutually satisfactory to both parties. In fixing the rates of skilled workmen the employer is expected to pay attention to the prevailing rates in the district for fully trained and skilled men. The unions disclaim any right to interfere with the wages of the men other than their own members, but, under the agreement, have the right in their collective capacity to arrange the rate of wages at which their members may accept work. General alterations in the rate of wages in any district are to be negotiated between the employers' local association and the local representatives of the trade union or unions concerned. The agreement concerning apprentices is an unusually sensible one. It provides for no recognized proportion of apprentices to journeymen but authorizes the unions to bring forward for discussion the proportion of apprentices generally employed in the whole federated area. This means, probably, that where more apprentices are employed than customary, the union shall have the right of talking the matter over with the employers. The agreement further states that the apprentice shall be afforded facilities for acquiring a practical knowledge of the branch of trade he adopts and shall be encouraged to obtain a theoretical knowledge of it so far as circumstances permit. This is already the practice in a good many of the leading British works, where apprentices are required to attend evening classes and in some cases are rewarded by prizes for specially meritorious work. The agreement also specifically provides that employers have the right to select, train and employ those whom they consider best adapted to the various operations carried on in their workshops and to pay them according to their ability as workmen. The employers have full discretion under the agreement to appoint men they consider suitable to work all their machine tools and to determine the conditions under which they shall be worked.

The most important section of the agreement is probably that which provides for avoiding disputes. Many employers have an extreme dislike to receiving union representatives and in some places men are reluctant to go to their employers with a grievance lest they be discharged. In the new agreement just signed due weight has been given to these conditions. Deputations of workmen will be received by their employers by appointment for mutual discussion of any question in the settlement of which both parties are directly concerned, or it will be competent for an official of the trade unions to approach the local secretary of the employers' association with regard to any such question, or it shall be competent for either party to bring the question before a local conference to be held between the local association of employers and the local representatives of the trade unions. Local conferences are to be held within twelve working days from the receipt of the application by the secretary of the employers' association or of the trade union. Failing settlement at a local conference it shall be competent for either party to refer the matter to the executive board of the Federation and the central authority of the trade union concerned. The agreement provides that there shall be no stoppage of work, either partial or general, but work shall proceed under the current conditions until the procedure indicated has been carried through. The agreement specifies who shall be considered local officials of the union, and refuses to permit an employer who declines to employ trade-union men to sit in the central conferences composed of members of the executive board of the Federation and members of the central authority of the trade union, called to consider questions which the local conferences cannot decide.

The new agreement has two significant features. The first is the centralization of authority on the part of both employers and trade unions. The men who are intrusted to represent each party to such an agreement will naturally feel the weight of their responsibilities, and will be less inclined to act hastily concerning controversies that may affect the entire industry in which they are interested throughout the kingdom. This centralization of authority is simply another indication of the tendency of the times and must be accepted as inevitable and probably as advantageous. The other important consideration to be observed is the added security given to the workmen on account of the Employers' Federation standing between him and any arbitrary and unreasonable employer. The day of the all-around mechanic has practically disappeared. A man may learn to run one or two tools, but that is about all. If he becomes a planer hand he will probably remain a planer hand for life, going from one shop to another and doing different kinds of work at them, but still working on a planer. As a result of this condition he cannot shift so readily from one employment to another as could the man who worked in the old-fashioned way. He naturally must seek some measure of protection and there is no way which furnishes such protection as the well-managed trade union. It is a fact of the deepest social significance, therefore, that the full recognition of the leading British trade unions engaged in the machinery industry, which is accorded by the agreement under consideration, has met with approval rather than criticism by the most conservative organs of the employers of such labor. Let us hope that all parties to this new agreement will live up to its spirit of fairness and mutual consideration, so that the British engineering trades may regain the strength and vigor they possessed ten years ago.

Engineering Education in France.

It has generally been understood that the system of education in the Polytechnic School and the School of Mines of France was a matter of great pride to French engineers. Accordingly it is surprising to learn that there is a feeling of considerable doubt among them of the advisability of the theoretical instruction in these institutions. The vice-director of the School of Mines at Paris, M. André Pelletas, is among those who recently have expressed a fear that the instruction was too much along the lines of higher mathematics. These views have been held for some time by engineers who have not had the advantage of a polytechnic education, but their recent confirmation by men who graduated from the great national schools and have since achieved distinction is attracting considerable attention. The Polytechnic School is the leading French technical institution, its graduates being ranked above those of the Central School of Arts and Manufacturers, where a more practical training is given. The graduate of the Polytechnic School has a certain distinction which helps him to obtain employment and tends to facilitate his advancement. The officials of the French railways are largely drawn from the ranks of the graduates of this school and most of the technical staff of the national government were educated at this institution, which, indeed, was established in 1794 to furnish specially trained men for government service.

The course of instruction at the Polytechnic School is largely mathematical, and the other portions of it are influenced considerably by the consideration that many of the students enter the army. The graduates of high standing have a large number of openings in the state service from which they may choose, while the men at the lower end of the class have to take what is left after their superiors have made their selection. The range of these positions is something astonishing. In the army, there is a choice between the artillery and engineering branches. In civil life there are situations in the state mining departments, the bureau of bridges and highways, on river and harbor improvements, in lighthouse construction and maintenance, in the supervision of state monoplies of tobacco, matches and powder, in the inspection and the technical and commercial administration of railways, in the postal and telegraph service, in naval architecture, on hydrographic surveys and in various other lines of work which it is hardly necessary to enumerate. In order to equip the polytechnic graduate for many of these positions it is necessary for him to attend a further course of study in some other school. His highly theoretical training has been so deficient in practical subjects that a three-year course at the Mining School is therefore essential. Some of the students at the Mining School do not attend the Polytechnic School before they take up the practical courses of the former, but they are not ranked so high as the Polytechnic graduates. At the Mining School they study various practical subjects and at the same time, however, have to review the higher mathematics which they learned at the first school. As a result of the long period of education and their army service, the average of the graduates of the Mining School who also studied at the Polytechnic School is about 28 years.

The critics of this system of education assert that a large part of the time spent at the schools is practically wasted. They believe that the graduates would be just as well educated in every sense of the term if they pursued advanced theoretical subjects to a far smaller degree. They also believe that a feeling of general distrust of the national technical educational system is arising. The managers and technical directors of many of the largest industrial works are drawn from the graduates of the schools named, and there seems to be a sort of understanding among them that the men promoted to the higher positions in their works should be other graduates of the same schools. Consequently a young man whose education has not included a course in the Polytechnic School, who has shown great ability in working up through any department of the industry with which he is connected, suddenly finds his advance to the highest positions blocked in favor by somebody who has shown by no means the same ability as himself.

It is interesting to notice that these severe criticisms of French engineering educational methods are not from those who have failed to achieve distinction but from eminent graduates of the schools themselves. If half of what they say is true, and certainly their standing warrants the acceptance of everything they assert as an accurate presentation of actual facts, then it is high time for a reform. The situation, in fact, resembles in many respects that in Great Britain some ten years ago, when the educational methods there were so severely shaken up by some of the leading scholars of Great Britian. The rumbling of that disturbance even echoed through the United States and The Engineering Record can bear witness to the fact that some three or four years ago the British mathematical reforms were the subject of widespread interest in the United States.

Notes and Comments.

Mr. George Westinghouse has the sympathy and good wishes of all Americans who delight in good work well done. For the second time in his career financial troubles are interfering with some of the great enterprises he founded and has carried on. He met the first crisis successfully, and carried forward the many enterprises in which he was interested until at the present time there are thirty-one Westinghouse companies in this and other countries, having a total capital of $120,000,000 and an annual output estimated to be worth about $90,000,000. Some 38,000 men are employed by these companies in twenty-four factories, turning out products of every sort. The air brake which has made high-speed railway traffic possible, the introduction of automatic block signals to increase the safety of railway travel, the introduction of natural gas in the Pittsburg district, the development of electrical apparatus, particularly of alternating current apparatus, the development of steam and gas engines and many other things too numerous to mention, lie to his credit. All of these things have been pushed forward manifestly for some other purpose than personal gain. Any ordinary business man would have been satisfied with the success achieved in one of them, but the incentive of genius made it impossible for Mr. Westinghouse to withhold his hand from anything where he saw a chance to do good work. What he has done in the last few years has been of so much benefit to the world that there is every reason for anticipating more achievements by his compelling force. At the present time, while he is facing the difficulties of unsnarling the financial tangles of the affairs of some of his companies, he has the sympathy of all who appreciate in any degree what great contributions he has made to the nation's prosperity, and how much may still be expected from his creative genius.

A Railroad Announcement which has attracted little attention during the period of financial strain just passed was that of the sale of the Port Chester and the Westchester roads to the New York, New Haven & Hartford Railroad Co. These electric projects attracted much attention a year or more ago. They were looked upon as the beginning of real rapid transit in the section immediately northeast of New York City. One of them, at least, was begun in good faith for the purpose of building up a suburban transportation business in Westchester County and the Borough of the Bronx. The absorption of both companies by the New Haven road puts an end to all prospect for the time being of any competition in passenger traffic in the district in question. Whether this clinching of a monopoly will be to the detriment or to the advantage of the people served remains to be seen, although this journal is of the opinion that advantage rather than disadvantage will result. Both of the proposed roads had a rather unsatisfactory termination near the end of the Lenox avenue subway, while the New Haven road will hardly be satisfied with any such crossroads terminal. Probably very few people know just what the New Haven company proposes to do, but it seems reasonably certain that such a great corporation will never be satisfied without its own station in the Borough of Manhattan, even if it has to build a great subway system to attain its purpose.

The Curtailing of Expenses ordered by the Pennsylvania Railroad directors during the coming year is something which should occasion no surprise. That road has been spending money for a number of years with a lavish hand; in fact, some people have looked with apprehension upon the great expenditures that have been made. A large part of the work for which these great sums have been paid out is now practically complete, and a heavy reduction in construction expenses can be made without affecting traffic to any extent. In view of the present financial troubles and the prospect of tight money, which a year of presidential election always presents, there is manifestly every incentive of going slowly for the next few months. It is understood that those works which affect the public convenience in any direct way will be pushed along with the same vigor as in the past, but that undertakings mainly to the advantage of the company will be checked until the normal condition of affairs is again assured.

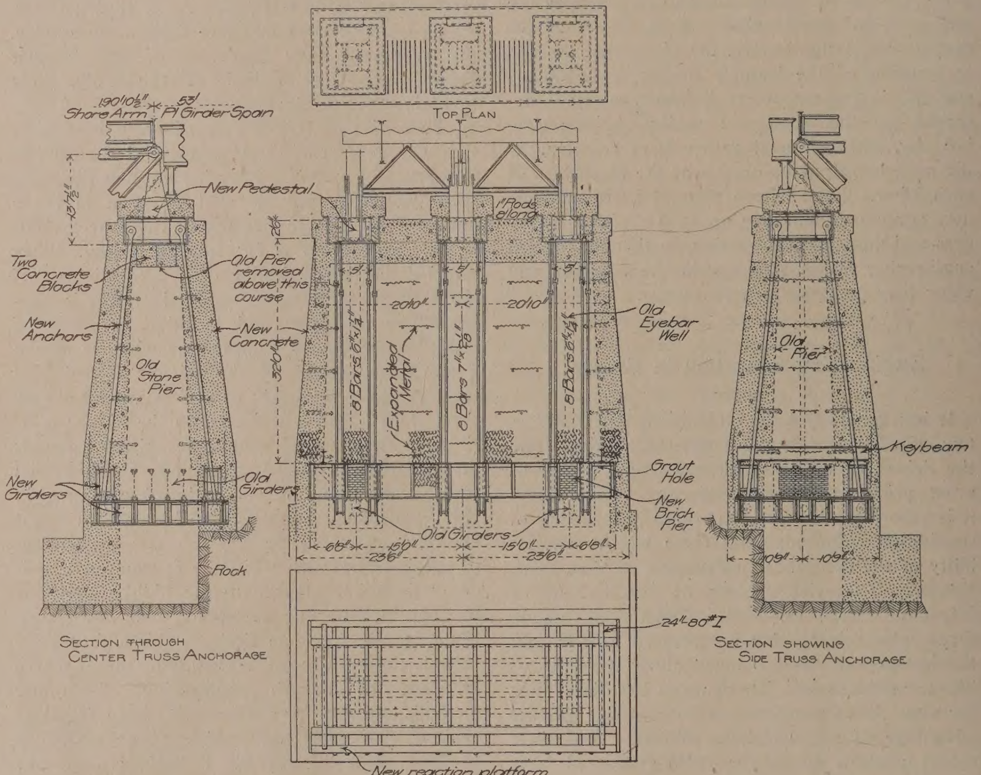
THE RECONSTRUCTION OF THE ANCHOR PIERS OF THE POUGHKEEPSIE BRIDGE.

The double track bridge over the Hudson River at Poughkeepsie was, when built, one of the first and most important long-span high railroad bridges in this country and was one of the first examples of cantilever erection. It has a total length of 6,747 ft. and a height of 212 ft. from the surface of the river to the base of rail. There are five main spans of 525 to 548 ft. lengths, besides high steel approach viaducts, with spans of 53 to 175 ft. The sub-structure is of ashlar masonry, with the river piers supported in deep water on very long footings. The superstructure is of steel and was proportioned for a live load on each track, consisting of two coupled locomotives, each with four 24,000-lb. axle loads, followed by a train load of 3,000 lb. per linear foot. After many years of constant use and hard service it was found that the bridge structure needed extensive reconstruction to endure the present heavier traffic and provide for a live load increased to 45,000 lb. on each locomotive axle and 3,600 lb. train load per lineal foot.

After a careful inspection and the study of alternate plans, it was decided to build additional columns in the viaduct towers, to provide new trusses and reinforce the existing trusses in the longer approach spans, to replace the short approach spans with new plate girders and to add a new line of center trusses between the old trusses of the main spans and new towers to support them. It was also necessary to make extensive alteration in the masonry and to provide entirely new and increased anchorage for the ends of the anchor-arm trusses. A general outline of the work was published in The Engineering Record of Oct. 28, 1905, and was followed on Aug. 18, 1906, by a description of the very novel and interesting methods used in replacing the short spans of the viaduct at a great height without the use of falsework. Since then work has progressed on the longer viaduct spans, on the main spans and on the substructure, and this article will describe the difficult and hazardous operation of reconstructing the anchorage piers and anchorage system while the bridge was under traffic.

The original west anchorage pier was about 48 ft. high, 7 ft. wide and 36 ft. long at the top and 11 ft. wide by 41 ft. long at the base, and had footings seated partly on the solid rock and partly on an inclined stratum of clay. Four longitudinal plate girders 4 ft. deep and 36 ft. long were built into the lower part of the masonry and served as a reaction platform for two vertical chains of eyebars, one in the plane of each truss, which passed between the girder webs and were connected to transverse bearing girders at each end. When the pier was constructed the bearing girders and portions of the reaction girders above them were left exposed in rectangular chambers 6 or 8 ft. long on each side, communicating with vertical wells about 2 ft. square to receive the anchor chain eyebars. The chambers were entirely closed at the bottom, and no access was provided to them through tunnels or in any other manner, but the vertical wells were left open at the top, thus exposing the eyebars and girders to the atmosphere and to rain and snow, but still leaving them inaccessible, as the space in the well was not sufficient to provide entrance for inspection or painting. Water accumulated in the undrained and unventilated chambers, and when a recent thorough inspection of the substructure was made it was found that the condition of both masonry and iron work required very prompt and extensive repairs and reinforcement.

The foundations were not considered satisfactory for modern requirements, and it was decided to improve them and to add materially to the mass of the pier masonry and increase its effective value for anchorage purposes by enclosing the old pier with a thick shell of new concrete thoroughly bonded to the former structure and arranged to greatly increase the anchorage load on the reaction platform. New anchor bars and reaction girders were provided, making the construction of the pier almost entirely new, except that part of the weight of the old structure was retained to provide for the negative reaction. The condition of the masonry and iron work was such that great care had to be taken to prevent any possibility of weakening it. The work thus became very delicate and hazardous and was conducted with the utmost skill and precaution.



Anchorage Pier with New Eyebars and Additional Reaction Girders.

In the reconstructed anchor piers the old reaction girders remained bedded in position in the base of the masonry and served merely to distribute a portion of the increased upward reaction against the old masonry. Three sets of new transverse girders are set in the lower part of the pier, projecting at both ends beyond its outer face so as to form cantilevers, receiving on their upper flanges two sets of longitudinal box girders, one on each side of the pier close to the old masonry. The latter form a reaction platform, on which is built a large amount of new concrete facing, enclosing the old pier and nearly doubling its volume. This arrangement greatly increases the available amount of counterweight in the pier and transfers it to the combined system of old and new reaction girders, which are connected to new pedestals, receiving the ends of the anchor arm by means of inclined adjustable eyebars bedded in the new concrete outside of the original limits of the pier.

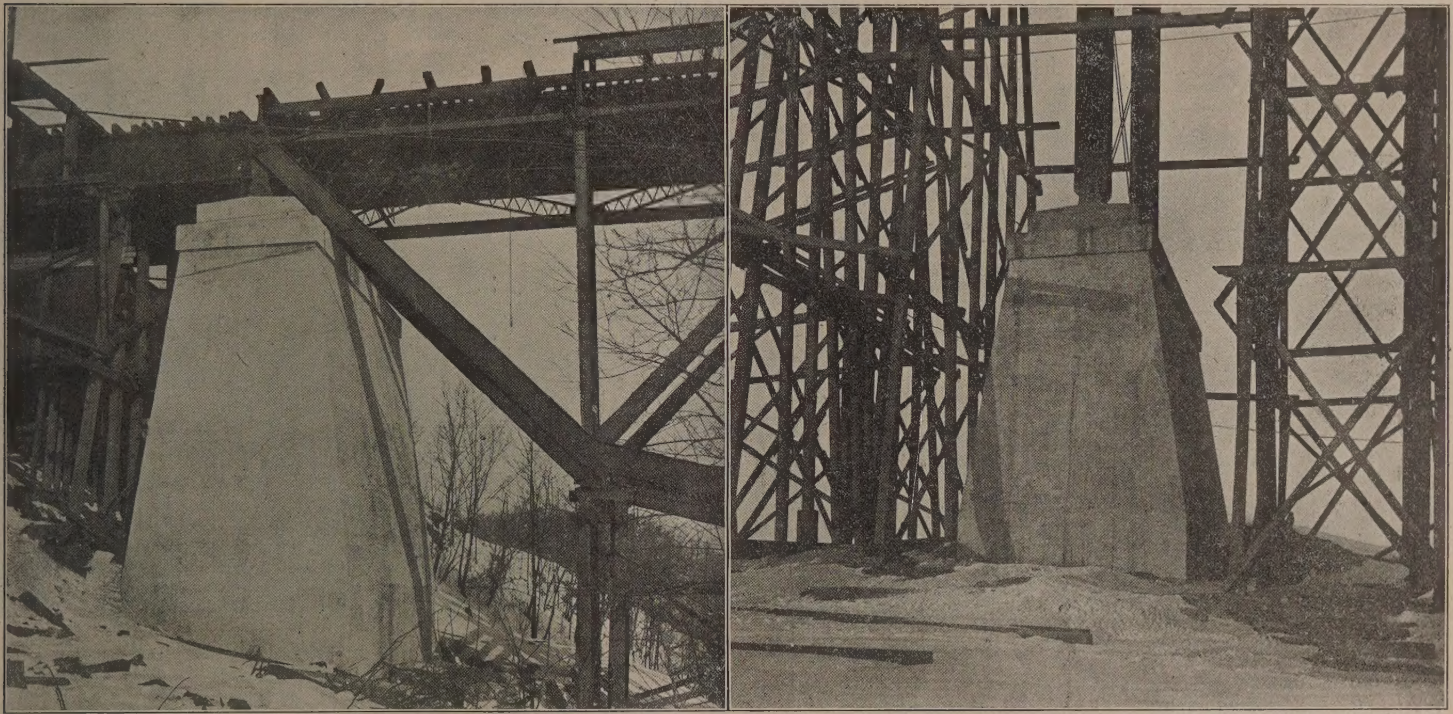
The foundations were reinforced by the construction of a concrete buttress 11 ft. wide, 50 ft. long on the east, or down hill, side of the pier, which was carried down about 20 ft. to the foot of the old masonry to extend it and give it a much greater stability against displacement over the inclined surface of the rock. It was built in short sections in sheeted trenches, so that only a small part of the old masonry was disturbed at any given time, and the stability of the pier was considerably increased before any attempt was made to cut the old masonry.

After the inspection and drainage of the old anchor pit a few face stones were removed at the bottom of the pier, and sufficient masonry was cut out to give access to the chambers in which the transverse girders already mentioned were located. The masonry was in such a condition that hesitation was felt in cutting much of it away before additional support was provided, and piers of hard burned brick were therefore built with great accuracy and care between the reaction girders and carried up to bearing against the masonry which formed the roof of the chambers. Sufficient space was left at one end of the chamber for the bricklayers to retreat downward between the yoke girders, and the brick piers were underpinned by concrete placed in forms in the planes of the trusses between the transverse girders. Afterward oblique holes were drilled through the outer wall of the pier to the vacant part of the chamber, and thin, fine concrete under pressure was forced through them from the exterior to fill all cavities between and around the brick work and consolidate it with the old masonry to form solid supports, encasing the girders and carrying the positive reactions down to the footings.

The next operation was to cut horizontal transverse holes through the masonry at the center of the pier and under each of the old trusses of the bridge just below the bottom flanges of the old longitudinal reaction girders. In these holes the new transverse or yoke girders were placed and blocked up to the required height. Steel wedges were then very carefully driven between their top flanges and the bottom flanges of the old reaction girders, insuring a solid contact between them.

There were in all six transverse girders, each of them being a box girder 3½ ft. deep, 2 ft. wide and 19 ft. long over all. They projected about 4 ft. beyond the face of the old masonry at each end, forming cantilevers, on which were seated, each side of the pier, a longitudinal reaction girder, with a rectangular cross section made up of two 5-ft. plate girders, 43 ft. long and 30 in. apart on centers, web-connected by vertical transverse diaphragms. New anchor bars, inclined somewhat from the vertical, were connected to both extremities of all the transverse girders by 6-in. pins and were enclosed in wooden boxes to give them clearance from the concrete.

In order to key the new concrete to the old masonry a 24-in. 80-lb. transverse I-beam, 18 ft. long, was seated on the tops of the longitudinal girders at each end of the pier, with its web solid against the old masonry and the flanges on one side seated in slots cut to receive them in the pier. Horizontal holes 2 in. in diameter and 1 ft. deep were drilled in all faces of the piers in pairs about 3 ft. apart horizontally and 5 ft. apart vertically, and in them were wedged 1¼-in. anchor bolts 4 ft long, some of them passing through the webs of the 24-in. I-beams, and all of them intended to bond the new concrete to the old pier. Sheets of expanded metal were laid across the projecting end of the anchor bolts, and the pier was enclosed in a form in which 2x8-ft. vertical sheets of expanded metal were placed near the lower part, as indicated in the accompanying illustrations. The forms were filled up to the height of the eye-bar adjustments with 1:3:5 Giant Portland cement concrete, deposited very wet, and the spaces around the old anchor bars were grouted up to the same height.



East and West Anchor Piers of the Poughkeepsie Bridge after Reinforcement.

The pier was thus in a condition to sustain the computed negative reaction of 479 tons. In order to provide for the positive reactions during the transfer of connections from old to new anchorages, falsework bents, intended to support the new center truss of the east anchor arm during erection, were built at panel points of the main trusses, and the double transverse bent under the first panel point from the anchorage was extended to receive both old trusses, which were wedged to bearing on it, thus affording them support independent of the pier. On the opposite side of the pier falsework was erected to carry the approach span, and was connected, over the top of the pier, with the double bent by means of 24-in., 80-lb. longitudinal I-beam stringers, on which the railroad tracks were carried over the pier and independent of it.

This removed the positive loads from the pier tower, after which the top of the pier was cut down about 10 ft., and the upper surface dressed to receive a pair of 2-ft. 10-in. by 5 ft. moulded concrete blocks 83 in. wide, with narrow vertical slots on their opposite faces to clear the old anchor eye-bars when they were set on opposite sides of it, with their slotted faces in contact, thus forming a single pedestal. The concrete blocks, already hardened, were competent to receive their loads immediately without waiting a long time for the concrete to age, as would have been necessary if it was built like the remainder of that in the pier, in moulds. At the west end of the bridge conditions were different, and traffic was maintained across the anchor pier, from the approach to the anchor arm in another manner. The first span of the approach viaduct there is a 58-ft. plate girder, the river end of which was temporarily supported on a falsework bent, releasing the pier and tower. One panel of 8x16-in. longitudinal stringers was supported at one end over the falsework, and the opposite end on the end floorbeam of the anchor arm, and carried the tracks over the top of the pier.

All traffic on the bridge was suspended during one Sunday, and loaded cars were run on the anchor arm to provide a counterweight larger than the maximum negative reaction in the old anchor bars, thus releasing them. The anchor bars were cut off flush with the tops of the concrete blocks by pneumatic drills, boring through them edgeways holes of a diameter nearly as great as the thickness of the bars. The sides of the bars were nicked opposite these holes, and they were broken off, the pins backed out of their upper ends, and they were removed. The removal of the old eye-bars provided clearance for the placing of the new riveted steel shoes about 8 ft. wide and 9 ft. high, which overhang both sides of the pedestal blocks, and were pin-connected immediately to the new anchor bars at both ends, the connection to the anchor arm truss being made with an upper center pin. The driving of these pins restored the anchor piers to its original functions and permitted the withdrawal of the counterweight on the anchor arm.

The next operation was the tightening of the anchor eye-bar sleeve nuts until a stress of about 6,000 lb .per square inch was developed in the eye-bars. This amount was calculated to be sufficient to produce a compression in the masonry a little greater than the maximum amount of upward reaction and thus maintain a slight initial stress in the masonry, even when the tension in the eye-bars is maximum and preclude the possibility of upward motion of the pedestals.

The well holes around the new anchor eye-bars were grouted, and forms were built enclosing the shoe and the space between them and the exterior forms was concreted, completing the top of the pier, except around the shoes. The wells around the shoes were lined with tar paper, and forms were built around them on top of the pier and filled with concrete, entirely enclosing the shoe and forming a cap over the anchorage bars, which is separate from the main body of the pier, and can, if necessary, conform to a vertical movement of the anchorage bars without transmitting shearing stresses or any danger of producing cracks in the main concrete of the pier, while at the same time it forms a weatherproof cap over the well.

The work on the pier was necessarily slow and costly and was accomplished by an average working force of 30 men in about 80 days. The reconstruction of the east pier was substantially the same as that described for the west pier, except that the dimensions of the pier were different, and it was surmounted by a tall steel tower supporting the end of the anchor arm.

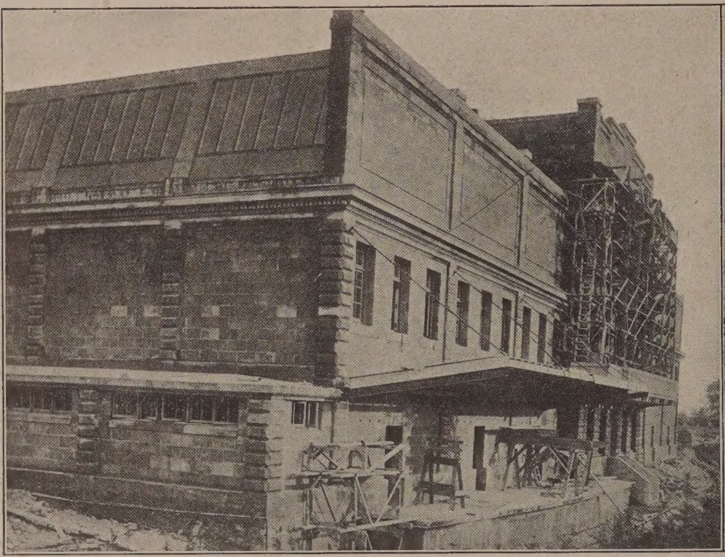
Additional interest is given this construction because it is believed to be the first built-in bridge anchorage. It has been heretofore considered imperative to provide anchorages with inspection wells or chambers, which leave some of the steel exposed to corrosion or possible injury. In such cases proper maintenace is likely to be difficult or impossible and is often neglected, and in several instances serious deterioration of the structure is known to have resulted. In this case it was decided to meet the problem squarely at first and assume final responsibility once for all by providing the most thorough protection and sealing it up. This may be radical, but is considered to be justified by the results of the opposite method.

In the reconstruction of the bridge Mr. Mace

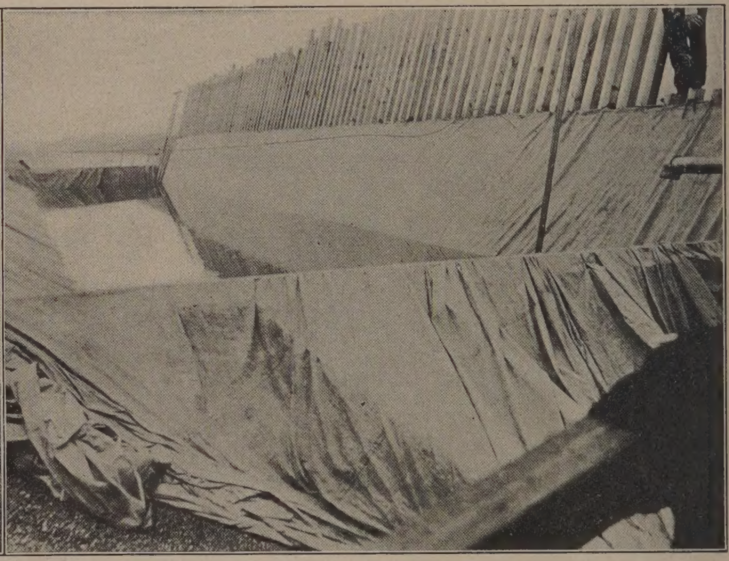
Moulton was consulting engineer for the railroad company. Mr. Paul Wolfel was the engineer in charge of design for the American Bridge Co. The methods and operations of erection were developed by Mr. S. P. Mitchell, who executed the work under a sub-contract from the American Bridge Co.

A Concrete Building for a Chocolate Factory.

A large chocolate factory under construction at Stamford, Conn., for Stollwerck Bros., present some unusual features of design among which are a reinforced concrete saw-tooth roof and framework and cement block walls. The structure is 500 ft. long and faces the north with its east end close to the bank of the Mill river. Counting from the west end, 100 ft. of the factory is 200 ft. wide; the next 100 ft. is 50 ft. wide; the remainder has a width of 100 ft. The long 100-ft. section is divided longitudinally by three lines of interior columns into four 25-ft. bays each of which is covered by a roof bay. Transversely the factory is divided into ten sections or "buildings," each of which has a separate entrance extending somewhat in front of the building proper, with toilet and shower bath rooms on each side, as shown in an accompanying illustration.



Office Section of Stollwerck Factory.



Water Test of Saw-Tooth Roof.

The exterior treatment was made extremely simple in order to avoid the necessity for making an undue number of special blocks, as this type of construction is only economical where standardization can be secured to a considerable extent. The facades are relieved by rustic piers, and crowned by a modillion block cornice, over which rises the front slope and the saw-tooth roof. There are no windows in the main building except in the part given up to office use on the west front, all the light for the factory rooms being obtained from skylights in the saw-tooth roof.

The foundations rest on gravel 26 ft. below the level of the basement which extends under most of the buildings. The part of the basement under the two center bays is unused, except for shafting and piping, and without a floor and high tides sometimes rise 2 ft. in it. The basement along the north and south sides and across the east end is divided from the rest by 3-in. walls and floored with a 5¼-in. slab, forming dry passageways, one of which on the south side is occupied by the rope drive system.

The main floor in general is designed to carry 300 lb. per square foot, though in Building 1, at the extreme east end where the boilers are placed, several girders and beams are designed to support a load equivalent to 1,200 lb. per square foot of floor area.

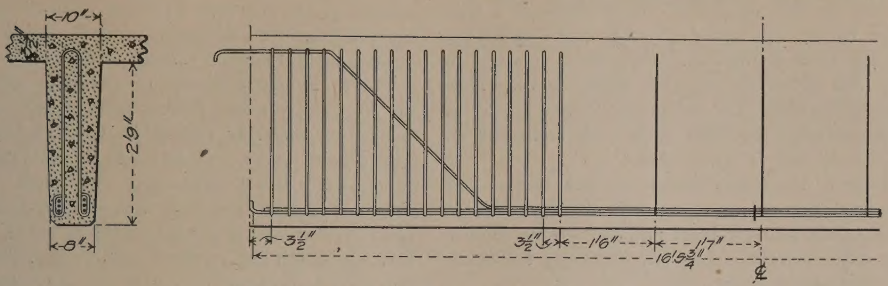
The general arrangement of the columns, girders, and beams supporting the main floor, which extends throughout the greater part of the factory, is shown in an accompanying floor framing plan. It will be noted that the floor in the center bays is carried by longitudinal girders and transverse beams which divide the slab into panels about 5½ x 25 ft., while over the outside bays the slab rests on the wall foundation, on longitudinal girder 10, and on two lines of longitudinal beams carried on 9 x 9-in. columns set in the basement passageways.

Referring to the framing plan, girder 2, on the longitudinal center line of the factory, is 33 in. deep, not including the 3½-in. floor slab, and tapers from 8 in. thick at the bottom to 10 in. at the under surface of the slab. It is reinforced with two 1 1/16-in. and four 1⅛-in. round rods and with 5/16-in. stirrups placed in general on 3½-in. centers, as shown in one of several accompanying diagrams. Girder 10 along the inside of the outside bays, has the same sectional dimensions as 2, but is reinforced with two ⅞-in. and four 15/16-in. round rods and has fewer 5/16-in. stirrups. The transverse floor beams, numbered 1, are 25½ in. deep, 6 and 8 in. thick at bottom and top respectively, and have four 1-in. round rods and 5/16-in. stirrups on 3½ to 18-in. centers. Beam 17 is 23¾ in. deep, not including the floor slab, which is 5¼ in. thick in the outside bays. It is reinforced with two ⅞-in. and two 15/16-in. rods and with 5/16-in. stirrups. The floor over the basement passageways is reinforced with ½-in. rods on 5-in. centers. In the center bays the reinforcement is ⅜-in. rods 4½ in. on centers.

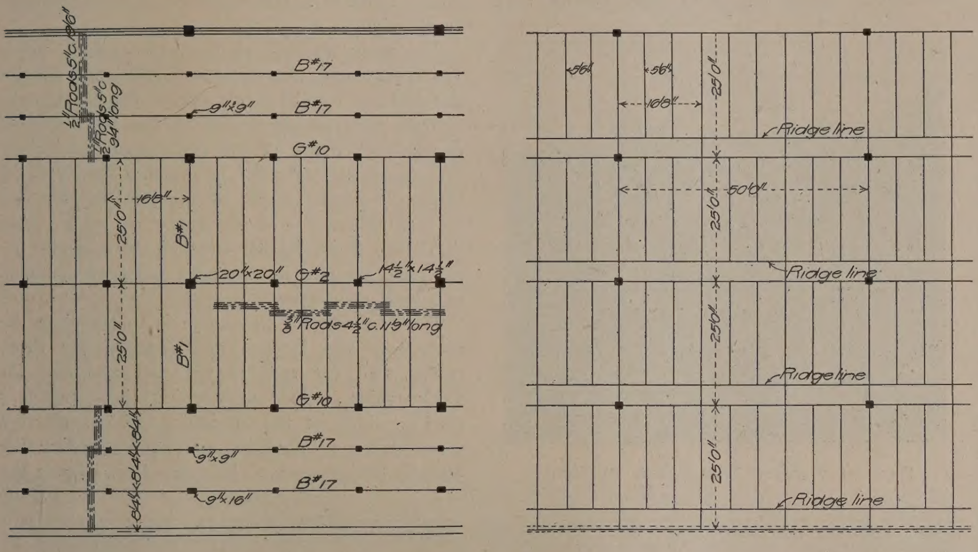
The principal columns extend through the main floor, supporting it and the roof as well, and have a clear height of 24 ft. 8 in. from the top of the floor to the under side of the roof girders. They are 20 in. square below the main floor and 15 in. square above it and have as reinforcement eight ⅞-in. round rods surrounded by 5/16-in. ties at 15-in. intervals. The end wall columns have the same section as the interior columns, but only half as many vertical rods. On the south side of the factory the regular wall columns are replaced by the heavier interior columns to provide for the addition of more bays in that direction. In the outside line of short columns in the north basement passageway every third one is 9 x 16 in. instead of 9 in. square. These heavier columns extend 12 ft. above the main floor and carry part of the weight of a 5-ft. by 7½ to 8¾-ft. reinforced concrete hot air duct which extends the entire length of the factory along the north wall. This duct is supported in 50-ft. spaces by the columns mentioned and, in a few cases, on the block division walls between the buildings; where the duct is carried on these walls a 6-ft. reinforced concrete lintel is provided in each wall to distribute the load. The duct has register openings in its top and bottom and in its free side. Its top serves as an inspection walk through all the buildings.

The saw-tooth roof is supported in 50-ft. spans by longitudinal girders 1 ft. wide and 51 in. deep carried on the several lines of columns. Each span is reinforced with sixteen 1-in. bars and with 5/16-in. stirrups arranged as shown in an accompanying diagram. These girders are intersected at intervals of 16 ft. 8 in. by the roof trusses which are made up of the long and short rake roof beams connected at their lower ends by tie beams. The beams in the short rake also serve as mullions between the skylights. Between each pair of truss beams in the long rake are two intermediate roof beams which are attached to the valley and ridge girders. The arrangement of these beams and girders is shown in an accompanying partial roof plan and the reinforcement is indicated on a section drawing. Special attention is called to the method of locking together the rods in contiguous tie beams at the intersection marked B. This was done by turning the tie beam rods through a quarter-turn so that the right angle bends at their ends hooked in opposite directions about the upper rods of the mullion beams. The upper ends of the latter rods are attached to the ends of the bent rods in the long rake beams by a wired splice.

The concrete used in the framework and roof is a 1:2:4 mixture of Vulcanite Portland cement and washed beach sand and gravel. The sand and gravel is delivered in boats at the east end of the building where it is loaded into two-wheel hand carts with a steam hoist and hauled to storage piles about 200 ft. from the river in front of Building 2 and near the mixer. The latter, a No. 3 Ransome machine, is mounted on an elevated platform and delivers to wheelbarrows or two-wheel carts on the ground. Above the mixer are measuring hoppers and above these are two bins for sand and gravel with a combined capacity of 30 cu. yd. These are supplied from the storage piles by stiff-leg derrick operated by a Lidgerwood three-drum hoist. A 60-h.-p. Ames boiler supplies steam for the mixer and hoisting engines. A platform elevator, operated with a Lidgerwood hoist and handling two



Floor Girder, No. 2, Stollwerck Factory.



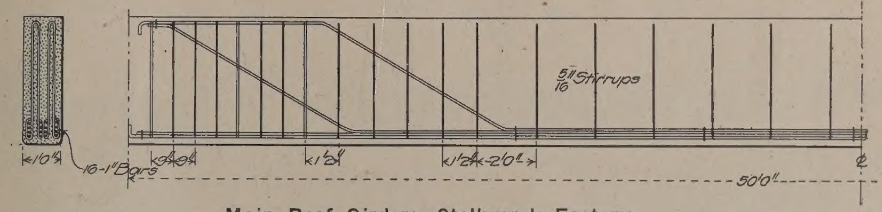
Part Plan of Floor and Roof. Stollwerck Factory.

carts or three wheelbarrows, delivers the concrete to platform runways at suitable levels to serve the various parts of the work, and is moved westward as the work progresses.

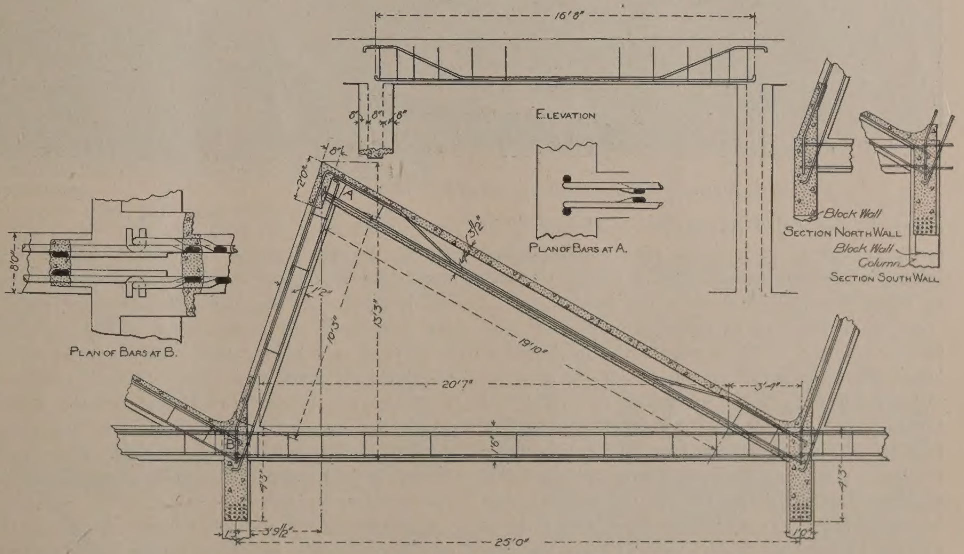
The unit system of reinforcement was used throughout the structure in the beams, girders and columns. This system, which has already been described in detail in this journal, involves the fabrication of the reinforcement for each girder or column into a unit in the shops of the contractor. These units are delivered on the work ready to be placed in the forms, each unit bearing a mark indicating its proper place in the structure.

In constructing the saw-tooth roof the columns were poured first; then the centering for the lower roof slab, the main girders, tie beams, mullions and all other roof beams was erected, 4 x 6-in. vertical posts thickly set and carefully braced being used for supports. The concrete for the lower roof slab and all the beams and girders was poured at once, the work being carried forward by a force of about thirty men who completed on the average one 50-ft. section over one bay in a day. The upper roof slabs were made and placed in 5½x25-ft. panels and covered with tar and gravel roofing. Copper flashings are provided at all projections and openings.

The ornamental cornice along the facade of the building was run on metal lath in place on the main girder at the top of the block wall, the attachment being made by means of brackets fixed in the girder at 2½-ft. intervals. These brackets are formed of three pieces of 2x2¼-in. angles. Two of these pieces project from the face of the girder horizontally near its top and bottom, the one at the top extending out further than the one below. The outer ends of these pieces are connected by the third piece with which slopes diagonally downward and inward. The upstanding leg of each diagonal piece is pierced with four ⅜-in. holes through which are strung ⅜-in. round rods.



Main Roof Girders, Stollwerck Factory.



Section of Saw-Tooth Roof, Stollwerck Factory.

The wall blocks are made of a 1:2:4 mixture of Atlas Portland cement and washed sand and gravel and were formed in a machine made by the American Hydraulic Machine Co.

Two separate load tests were made on the saw-tooth roof. In the first test bags of sand were piled in the valley in the form of a pyramid with its apex at the center of the girder. The total load of 84,800 lb. was applied in such a way as to produce a bending moment on the girder equivalent to that produced by the dead load plus four times the live load which the roof was calculated to sustain. The deflection of the girder at the center under this load was 0.20 inches. The second test load was extended over two adjacent girders for the purpose of testing one of the columns. The method of loading was different from the first test, water being used instead of bags of sand. A canvas bag lined the interior of the valley and was supported by planking along the skylights and at each end. The length of the trough thus formed was 100 ft., and its section was triangular, the sides being parallel to the slope of the roof. The pocket thus formed was filled with water to a maximum depth of 5¾ ft., a total load of 332,000 lb. being thus applied. This was equivalent to four times the calculated live load over an area of 100 x 25 ft. The deflection of each girder at its center under this loading was 0.10 in. Upon the removal of the load the girders recovered almost entirely.

The peculiar virtue of the system of loading adopted in the second test lies in the absolute mobility of the load which prevents the arching effect which sometimes occurs when a very heavy load is applied in solid form. It would be expensive to apply this method of loading in a single test unless the material of which the water-tight receptacle was made could be used afterward for some other purpose, but where a number of tests in series are contemplated it would probably be as inexpensive as the ordinary system of loading.

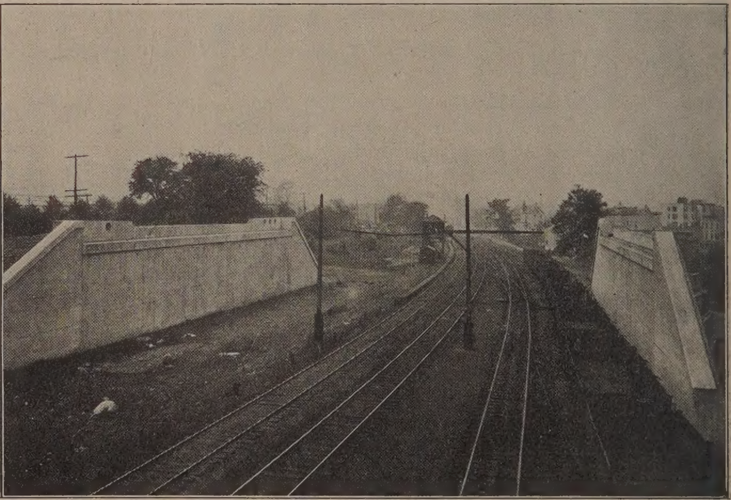
The architectural drawings for the factory were prepared by Mr. Ernest Flagg, architect, New York City, and the structural designs were prepared and the work is being executed by Messrs. Tucker & Vinton, of New York City, Mr. R. L. Bertin, chief engineer, Mr. P. H. Trout, superintendent of construction.

Open-Hearth Steel Rails have recently been ordered by the Great Western Railway Co., of England, the first British company to place a contract for such rails.

Six-Tracking and Reconstruction of the Harlem River Branch of the New York New Haven & Hartford R. R.

The Harlem River Branch of the New York, New Haven & Hartford R. R. runs from a point near the junction of the Harlem and East Rivers in the Borough of The Bronx, New York City, northward beyond the limits of the city to New Rochelle, where it joins the main line. The latter runs westward at this point to Mount Vernon, where it connects with the New York Central & Hudson River R. R., and thus secures an entry into the Grand Central Depot in the heart of Manhattan. The Harlem River Branch carries a very heavy freight traffic which is received and dispatched at the Harlem River Station on car floats which connect with the various railroads in New Jersey, running west from the Hudson River. Considerable freight originates, too, in the territory neighboring the southern end of the Branch, the banks of the Harlem and the East Rivers affording particularly advantageous sites for industrial establishments. The passenger traffic, consisting entirely of suburban travel to various points in the Borough of The Bronx, already a very heavy one, has been increasing rapidly owing to the marked development of this portion of New York City during the past few years. At the Harlem River Station, the southern terminus of the Branch, there is no rail connection of any kind, the passengers transferring as a rule to the Third Avenue Elevated System in order to reach the business part of Manhattan Island, while the freight, that requires transfer to other roads, is handled by car ferries.

Fill and Completed Abutments at Port Morris.



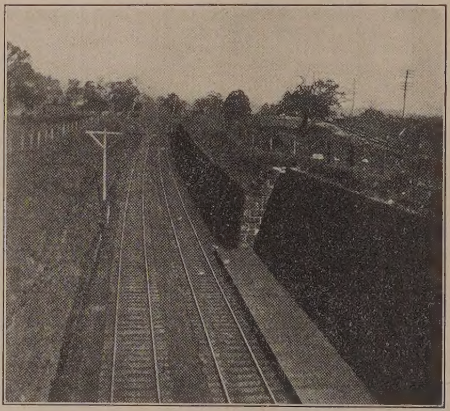
Completed Abutments at White Plains Road.

A steady increase in passenger and local and through freight business caused the adoption of broad plans for improvement, which are now being carried out. Before starting reconstruction the road had two tracks from the Harlem River Station to Pelham Manor and four tracks from the latter point to the junction with the main line at New Rochelle. The present work consists in four-tracking the road from the Harlem River Station to the Oak Point Yard and six-tracking the remainder of the line, at the same time making such changes in the layout of the stations, in the yards and in the grades both of the railroad and of the intersecting streets as were necessary to realize the greatest efficiency from the new plans and make unnecessary any future rearrangement of street crossings.

At the present time there are car ferry transfer bridges both at the Harlem River Station and at the Oak Point Yard, but when the latter has been fully developed the use of the transfer bridges at the former station will be discontinued, only such freight as originates locally at the industries on the Harlem and East Rivers being handled on the line south of the Oak Point Yard. New transfer bridges, and additional tracks are being constructed at the latter point so as to handle all of the through freight traffic.

Four of the tracks in the six-track section will be used for passenger service, the two outside ones of the four for local, and the two inside ones for express trains. The two tracks to the south are for freight traffic.

There are thirteen passenger stations on the Harlem River Branch, two of them having been established since the reconstruction was started. All of the old stations are being replaced with handsome structures differing in design to suit the location. At the local stations there will be but two platforms, one on the outside of each local passenger track, and at the express stations one local platform along the outside of the local track nearest the station building, and two island platforms, one between each pair of passenger tracks of like movement. Access to these platforms is had through reinforced concrete subways under the tracks.



Part of Former Two-Track System.

Coincident with the other improvements is the change of grade in order to eliminate railroad crossings at street level. At the south end the railroad tracks are on a fill and the streets which cross the line are spanned by plate girder bridges, while on the north end the tracks are at about the level of the surrounding land and the streets cross the right of way on overhead highway bridges. There are 56 bridges in all, in a total distance of 11½ miles, the length of the Harlem River Branch, the spans varying from 44 to 197 ft. Plate girders are used for the short spans and riveted through truss bridges for the long spans. The alignment has also been benefited in the improvement work, the additional property being purchased so as to make easement possible.

There are two crossings of navigable streams, the Bronx River and Pelham Bay, which will be crossed on Scherzer rolling lift through bridges. The channel spans will be 70 ft. in the clear between the fenders protecting the piers. The length of the crossing over Pelham Bay is about 1,600 ft., for which a pile trestle is being built. Near the south end of the branch at Port Morris, provision is being made for the future construction of the tracks of the New York Connecting R. R., which is to cross over the East River from Long Island.

The work was started in October, 1905. Provision was made for maintaining both the passenger and the freight traffic during construction by shifting the running tracks at the south end to one side while the fill was being made, and while the abutments and piers were being built for the bridges. Practically all of the material for this fill was obtained from the largest cut on the line, at Hunt's Point, 85 per cent. of the material being rock, some of it very hard and grading down to a soft disintegrated schist.

The plan on the fill section is to complete the abutments and bridges and roadbed for three tracks, two for running purposes and one for work trains, before abandoning the temporary tracks, which at the beginning of construction were placed to one side in order to allow the fill and bridge work to be carried on. From the present rate of progress it is probable that trains will be put on the fill within the next six or seven weeks. At the north end of the work where the tracks follow, in the main, the level of the surrounding ground, the running tracks were shifted so as to accord with the best methods for handling the work under the local conditions.

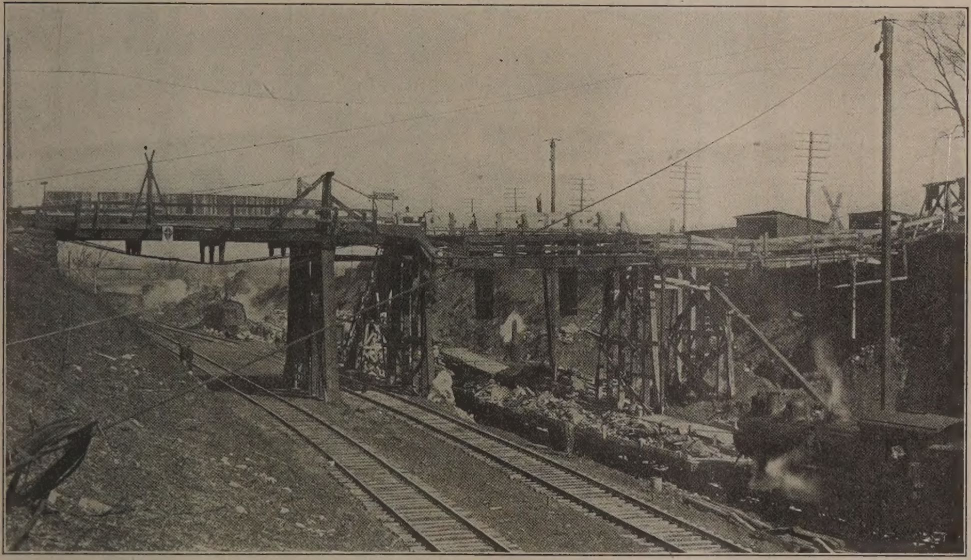
The sections for the piers and abutments have been made very heavy on account of the treacherous nature of the material along the right of way. Much of the land is very low and is entirely underlaid with marsh and swamp deposits. At the south end piles had to be driven for all of the abutments and piers, their length varying from 25 to 50 ft., in order to reach rock. The average length was about 35 ft. The driving at the surface is very easy for 10 to 15 ft., beyond which a somewhat harder material is encountered for a distance varying from 5 to 10 ft., followed by hard driving and then rock. In some places fills of miscellaneous character were encountered which gave considerable difficulty in driving. Some of these were of rock fill, others of ashes and garbage wastes. The wisdom of selecting the heavy sections was proved after the fill had been started, when the weight of the deposited materials squeezed out the muck on either side into humps and ridges 5 to 6 ft. high.

The formula for the width of the abutment where earth alone is to be retained is ⅓ of the height, plus 3 ft., and where the earth fill carries tracks, ⅓ of the height plus 4 ft. The tops of the piles are sawed off level and the concrete placed over them for a depth of 1 ft. The footing is reinforced with old rails running parallel to the length of the abutment. In addition to the vertical piles, batter piles are driven to secure greater stability.

The concrete for the abutments and piers is a 1:3:6 mixture, the rock being trap from the Connecticut quarries. For the bridge seats and copings 1:2:4 is used. Both Alpha and Lehigh Portland cements are used. The concrete was all mixed in 1-yard mixers placed conveniently at the work, and was put into place with bottom dump buckets, handled by stiff-leg or guyed derricks.

In Pelham Bay Park, the city authorities objected to the use of concrete, and stone was therefore used for the abutments of the bridges within the Park limits.

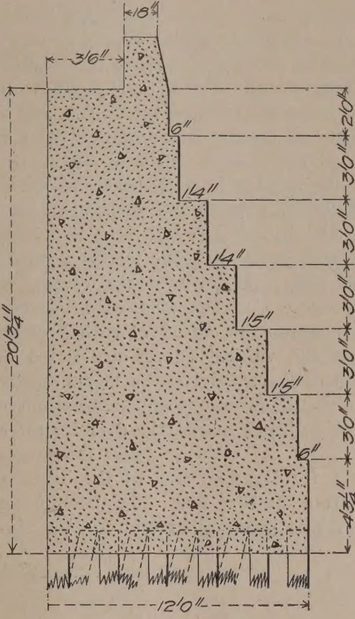
The angles at which the streets cross the right of way and the fact that in some cases a number of streets meet at the railroad necessitated some long bridges and abutments. The Bronx and Pelham Parkway crosses the right of way at a sharp angle, and the abutments and piers are being built for a width of roadway and footwalks of 400 ft. This made it necessary to build the abutments 780 ft. and the piers 710 ft. long. The railroad will provide a bridge 80 ft. wide. At another point, West Farms Road, East 180th St. and Adams St. join at the right of way and are carried over the tracks on a skew plate girder bridge, the abutments for which are respectively 333 and 318 ft. long.



Hunt's Point Cut, Showing Temporary Highway Bridge and Old Main Line Tracks.

Small toe walls were necessary in places to prevent the slopes going beyond the right of way line, and in one case along the Bronx River, a retaining wall with a maximum height of 15 ft. above high water and a length of 220 ft. was necessary.

Most of the new passenger stations are constructed with their floors at the level of the tracks, but in some cases are being built overhead. The platforms are to be 700 ft. long and are to be paved with concrete, cement finished. The stairways leading from the station buildings to the subways under the tracks and from the subways to the platforms are to be built of reinforced concrete, the steel consisting of 1-in. corrugated rods. The rods in the walls and the floor are on 12-in. centers in both directions, and in the roof on 12-in. centers transversely and on 4½-in. centers longitudinally. The inclined rods in the roof, shown in the illustration, are on 12-in. centers. The station buildings are to be of different designs in order to harmonize with the local surroundings, some of them of stone, some of brick, and some of concrete.



Abutment for Railroad Bridge.

The freight business along the line has been cared for by reconstructing the yards already in operation, and by adding others where necessary. These are merely large enough to handle the local business. The main freight yard of the branch will be, as is the case now, the Oak Point Yard. This is to be entirely reconstructed and increased in size, with a view to handling all of the through traffic, to and from the car ferries.

The tracks are laid on 13-ft. centers, except where station requirements and the crossing structures at Bronx River and Pelham Bay necessitated greater distances. The sub-grade, as shown in an accompanying illustration, is crowned from both sides to the center of the six tracks and is covered with rock ballast, the maximum depth of which at the sides of the six-track roadbed is 20 in. below the top of tie. Creosoted white pine ties are being used exclusively, and carry rails which weigh 100 lb. to the yard. About 3,800 cu. yd. of trap rock ballast are required to the mile for the six-track roadbed. The maximum curvature of the center line of the six-track system on the new alignment is 4 deg. 55 min., and the maximum grade is 0.65 per cent., at the point where the road goes up onto the fill at the south end. The greatest difference in grade between the new and the old lines is about 12 ft., in the cut, already referred to, at Hunt's Point.

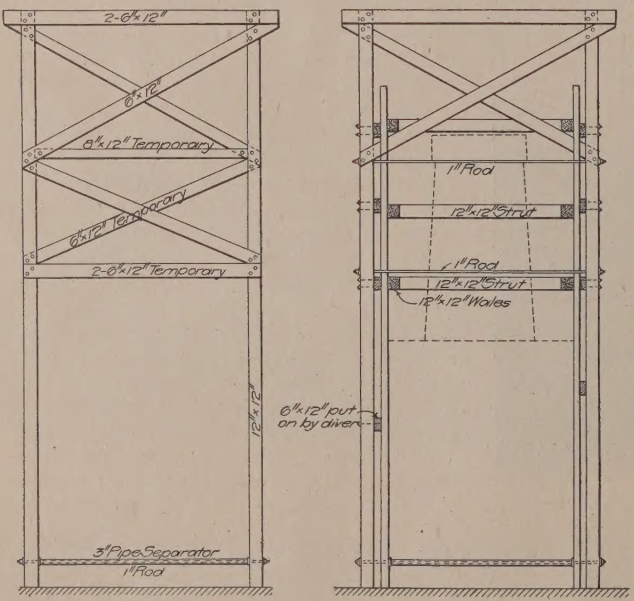
At a number of the streets crossing the right of way the railroad company is building new sewers, reconstructing old ones and providing suitable protection, from the heavy loads of the new filling material and the traffic, for some of the others which are already built. The new sewers are of reinforced concrete, some of them circular and others of an approximately rectangular section.

The Bronx River will be crossed on Scherzer rolling lift through bridges made of three leaves, each accommodating two tracks. The bridge and the river are at a considerable angle, and in order not to make a jog in the river so as to secure a right-angle crossing, or in lieu thereof, put a curve in the railroad, it has been necessary to step back the three leaves successively, each leaf being a right-angled one. This has necessitated complicated abutments and piers. The clear channel between the fenders, which are straight throughout their length, is 70 ft., 26 ft. more than for-

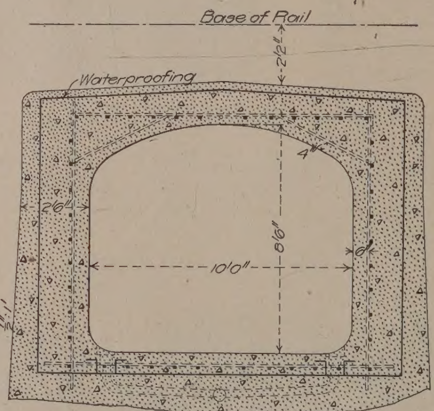
East End of Pelham Bay Trestle under Construction.

merly. The piers and abutments were founded either upon rock or upon good gravel beds. No great difficulty was found in building them, but the rock sloped sharply in places the distance from the top of the pier to the foundation in some cases being as much as 30 ft. more at one end than at the other. The footings are of 1:2:4 concrete, but the superstructure from a point well below the lowest tide level to the bridge seats is of granite. The concrete was placed under water by means of bottom dump buckets. The old bridge at this point was a center pier swing bridge of the through plate girder type carrying four tracks. The method of removing it was explained in an article of The Engineering Record of June 29, 1907. In order to accommodate the traffic during construction a temporary 2-track trestle and a 2-track jack-knife draw-bridge have been built immediately south of the permanent site.

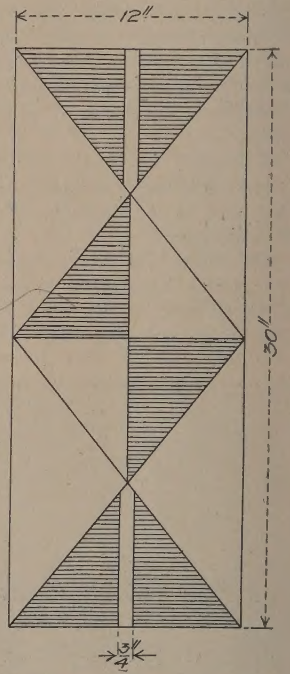
Pelham Bay Bridge and Trestle. The crossing of Pelham Bay consists of a pile-bent trestle 1,600 ft. long, near the center of which is the Scherzer rolling lift bridge, consisting of three leaves for two tracks each. There are 150 bents in the trestle, each containing 36 piles, 2 ft. 9 in. on centers transversely to the center line of the railroad. The bents are 10 ft. apart longitudinally. The bracing of each bent consists of 3x10-in. diagonals on each side of the piles, running from the horizontal bracing at mean low water to the cap. In order to reduce the unsupported column lengths the bents are braced together by 12-in. longitudinals, just above mean low water elevation. In order to prevent swaying longitudinally on either side of the draw-span special 4x10-in. bracing in vertical planes parallel to the direction of the track has been placed on the six bents on each side of the lift bridge.



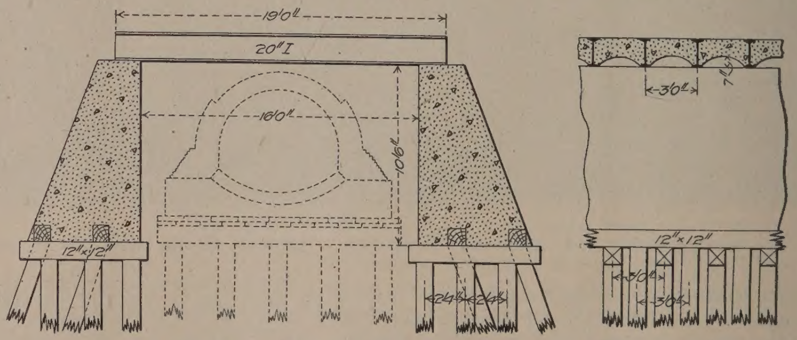
Original Bent and Section of Completed Cofferdam.



Passenger Subway under Tracks.



Surveying Target Used at Pelham Bay Trestle.



I-Beam Protection for Bungay Street Outlet Sewer.

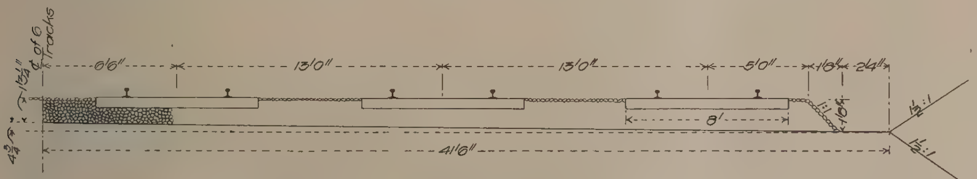
Both ends of the trestle are on 3 deg. curves. The tracks are laid in three pairs of two tracks each, the distance between the two tracks of a pair being 13 ft., and between the adjacent tracks of two different pairs 23 ft. The deck of the trestle is 12.9 ft. above mean high water. The piles in the portion of the trestle west of the draw vary in length from 22 to 50 ft., and east of the draw from 50 to 80 ft. They were driven to a ½-in. refusal, with a 5-ft. drop of a 3,000-lb. hammer. The piles are of long leaf yellow pine, with 8-in. tips and butts not less than 12 in.

The laying out and construction of a trestle of this magnitude required very careful work and close supervision in order to get the piles in each bent in a good line, to preserve the proper distances between the bents and between the individual piles and to secure the proper angles for those bents on the curves at each end of the trestle. In order to guard against any possible error, all of the data necessary for the construction, such as angles, plusses and offset distances, were carefully computed and checked and then embodied in tabular form in a large layout plan, which, in addition, contains a plan and an elevation of the trestle. The plan of the trestle shows the angles of all of the hubbed lines used in connection with the work, the P. C.'s and P. T.'s of the curves on the center line of the six-track system and of the north and south pairs of tracks, the number of each bent and the plusses of each bent, both on the permanent stationing and on the base line which was laid down for construction purposes. The trestle is on a grade at both ends and level at the center, with a vertical curve on each side of the draw-span. For this reason the cut-off of each bent and the data for the vertical curves are noted on the elevation of the trestle on the layout-sheet. The tables give the elevations and descriptions of the construction bench marks, the data for the curves at both ends of the trestle and the angles and distances for locating each of the bents on the curves from the base line. The data for running the curves is given separately for the six-track center line and for the north and south pair of tracks, the deflections being noted both for foresight and backsight.

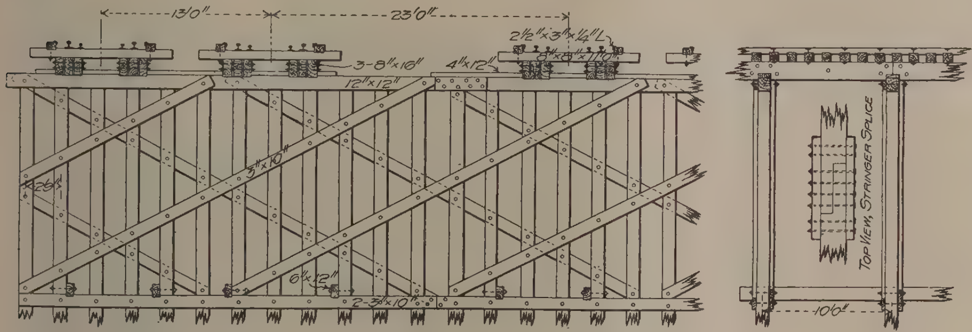
The center line of the six-track structure was first laid out and permanent hubs driven in secure places on each shore on the prolongation of the tangent. A base line was then laid down south of the structure, and on it the temporary trestle for accommodating the traffic during construction was built. From this trestle and the base line the entire new structure was laid out, the line for each bent being sighted from two nails driven in the deck of the temporary trestle. Permanent targets were placed above the hubs on shore on the center line of the permanent structure, on the base line and on the longitudinal center lines of the abutments and piers for the Scherzer rolling lift bridge. These targets, the design of which is shown in an accompanying illustration, were adopted as a result of a series of trials and have given entire satisfaction. The dimensions as shown have been used for distances up to three-quarters of a mile. The design of the targets as well as the computations and the method adopted in laying out the trestle, are due to Mr. L. D. Fouquet, who is in charge of both the Pelham Bay and the Bronx River crossings for the railroad company.

The building of the foundations and piers for the Scherzer rolling lift bridge proved a troublesome undertaking. The bed of the bay consisted of soft muck, which had to be removed. Solid rock was found at varying depths from —18 to —29, the elevation of mean low water being —5.1, and of mean high water +2.1. The entire site was dredged clean down to the rock by the International Dredging Co. Very accurate and complete soundings were then made by means of long gas pipes, in order to determine the topography of the rock bottom. With the data from the soundings, elevations, both transverse and parallel to the length of the abutments and piers, were platted, and stout frames for the cofferdams were constructed according to these profiles. These frames, after being placed in their proper positions, were loaded sufficiently to sink them to a bearing on the rock, and the cofferdam sheeting was then placed inside the framework. The framed bents when put in position contained temporary braces and struts, which were removed after the bents were lined up and when the sheeting was placed. The upper 6x12-in. clamps and braces were removed while the sheeting was being set and were then replaced. One of the illustrations shows a bent in the original condition and the completed cofferdam. As soon as the sheeting was set a diver was sent down inside the cofferdam and cleaned the rock perfectly by means of a jet of water, the washings being removed by a 12-in. centrifugal pump. The concrete was then placed under water by means of bottom dump buckets, the cofferdams serving as a form for the footings. When the latter had reached their proper height the cofferdam was pumped out, and the surface of the concrete carefully leveled for beginning the granite work for the piers. At the completion of the latter the nuts were taken off of the bottom rods and the cofferdams removed.

In the early stages of the masonry work precautions were taken to prevent the floating of the cofferdams, and the consequent disturbance of the concrete footings which plugged their bottoms. The head of water on the outside of the cofferdam in high tide was sufficient to more than counterbalance the weight of the concrete, providing the cofferdam above the latter was pumped out. For this reason the cofferdams were flooded at high tide until sufficient of the granite masonry had been placed to overcome the upward pressure due to the head on the outside of the cofferdam.



Half Section of Roadbed for Six-Track System on Harlem River Branch.



Half of 36-Pile Bent and Side View, Pelham Bay Trestle, Harlem River Branch.

The six-tracking work and the other improvements are being done under the direction of the engineering department of the New York, New Haven & Hartford R. R., Mr. E. H. McHenry being vice-president, in charge of engineering, and Mr. Edw. Gagel, chief engineer. Mr. R. M. Berrian, assisted by Mr. M. S. Jameson, was in charge of the work from February, 1904, until August, 1906, since which time it has been under Mr. W. B. Leonard, assisted by Mr. I. D. Waterman. The contractors are Messrs. Daly and Holbrook.

Tests of Concrete Blocks taken from the stock of the National Hydraulic Stone Co. of Baltimore have recently been made by Mr. Allen S. Crocker, M. Am. Soc. M. E., of Rochester, N. Y. There were seven specimens tested, one of which could not be broken by the testing machine which has a capacity of 200,000 lb. The other blocks had an average strength of about 2,907 lb. per square inch. The blocks were made on machines built by the Fisher Hydraulic Stone & Machinery Co., and only one of the specimens had been dampened more than twice within the first week after it was made. This one had a strength of 4,103 lb. per square inch. The lowest strength of any block was 1,178 lb. per square inch, due to the fact that the block was shipped when only 3 days old and had no water from that time until tested at 19 days age. The blocks were made of 1:8, 1:10 and 1:12 mixtures, and had bearing surfaces of 14 sq. in. or more.

Sewage Disposal Plant at Kew Beach, Toronto, Ont.

At the recent convention of the American Society of Municipal Improvements, Mr. C. H. Rust, city engineer of Toronto, read a paper on the sewage disposal plant at that portion of the city known as Kew Beach, situated at the eastern limit on the shore of Lake Ontario and solely a residential district. The level of the ground is only a few feet above the level of the lake and the soil sandy underlaid with clay. The property owners have been for some time asking for drainage, but owing to the municipality of East Toronto procuring their water supply from a point about three-quarters of a mile east of this district, and to the objection of the Board of Health to allowing crude sewage to be deposited in the lake, is was necessary to adopt the sewers and purification works as described. The drainage area of this district is one hundred and eighty-five acres, containing a population of approximately 10,000 during the summer months.

To ascertain the consumption of water a meter was placed upon this district, and it was found that the actual consumption per head in twenty-four hours was 16 gallons.

The main sewer is laid along the lake front at a depth varying from 2 to 9 ft. below the lake level and is constructed of 16 and 10-inch cast-iron socket pipes. All sewers from the north discharge into this sewer and at a point midway between the outfall and the summit is constructed pumping station No. 1, raising the sewage from the low level sewers from the east and north into the high level sewer which gravitates to No. 2 pumping station where the sewage is raised into the disposal works. These pumping stations are constructed of concrete and are circular in plan with a partition wall in the centre and have a reservoir space of 3,200 gal.; and each contains a duplicate set of pumps and motors, No. 1 consisting of two 5-h.-p. alternating vertical motors and two 4-inch submerged centrifugal pumps and No. 2 consisting of two 7½-h.-p. alternating vertical and two 4-in. submerged centrifugal pumps. Motors and pumps are automatically controlled by the rise and fall of the sewage in the reservoir.

The shafts of the pumps are connected direct onto the armature of the motors without any bevel gearing, which practically eliminates all noise whilst operating.

The disposal works consist of three septic tanks and twelve bacteria beds, constructed from plans designated by the Cameron Septic Tank Co. and operated by the gear patented by them.

The works are erected on the shore of the lake about 200 feet from the water's edge, and are supported by 10-in. piles driven 16 ft. through the sand and into the hard clay and surrounded by tongued and grooved sheet piling driven 14 ft.

The construction of these works is of concrete in the proportion of seven of broken stone and sand to one of cement.

The three septic tanks are each 100 ft. x 14 ft. x 7 ft. 3 in. deep at the low end with a total capacity of 183,750 gal. They are covered with a 3-in. concrete roof, made in the proportions of 4½ of broken stone and sand to one of cement and reinforced with 3-in. mesh, 10-gauge expanded metal. At 6 ft. 6 in. centres are 9x6-in. concrete beams supporting the roof, reinforced with ¾-in. Johnson's corrugated steel bars. An inlet channel feeds the three tanks at the high end, each one of which can be operated independently from this channel.

The distribution of sewage into the tanks takes place through one 8-in. pipe, thence through four 12-in. openings, 3 ft. above the bottom of the tank, which accomplishes a maximum flow of sewage with a minimum amount of disturbance. At the low end of the tanks thirteen 4-in. outlet pipes are built into the wall, 2 ft. 7 in. below the water line, connecting with the cleansing chamber and outlet channel. From here the main effluent carrier is built into the wall of the bacteria beds in line with the outlet channel of the septic tanks and runs the whole length to the end of the beds and has three branches at regular intervals, each feeding one set of 4 beds.

There are 12 bacteria beds, 3 sets of 4 each having a combined area of 1,860 square yards. Each bed is 50 ft x 28 ft. x 4 ft. 6 in. deep and is filled 4 ft. deep with furnace slag varying in size from ¼ in. to 1½ in. On the floor are laid 14 lines of 3-in. weeping tile collectors, discharging into a 9-in. main collector, and 6 in. below the surface of the slag are 6 lines of 6-in. weeping tile distributers fed by a 9-in. main distributer. All discharge pipes terminate in one common chamber from which a 15-in. main filtrate carrier is laid down to the lake, the last 30 ft. being supported on piles.

The sewage is raised to a height of 22.5 ft. at pumping station No. 2, into the inlet channel, which is below water line and extends to a point beyond the inlet to septic tank No. 3. From this inlet channel the sewage is admitted into each tank required to be operated through the submerged openings.

The effluent from the tanks flows through the submerged outlets and through the effluent chamber, which arrests any solid matter which may find its way through the outlet pipes in time of excessive flow and thence into the outlet channel.

The semi-clarified sewage now flows along the main effluent carrier and on to the automatic distributing gear from which it is distributed to each bed in turn through its admission valve. The discharge valve will be closed meanwhile so that the interstices of the filtering material will be filled with the tank effluent. The effluent remains in the contact beds for a period of about two hours, according to the rate of flow. The discharge valve will then open, when the filtered effluent escapes, drawing down after it a supply of air into every crevice of the contact bed. The latter will then drain and aerate whilst the remaining contact beds of the set are filling, after which it will again be filled in turn. This method of working renders the contact beds self-cleaning so that they retain their purifying power unimpaired.

The alternate filling and emptying of the contact beds is effected automatically by means of the alternating gear in the following manner: As soon as bed No. 1 is filled, a small quantity of filtered effluent overflows from its discharge well into a float chamber, lifting the float, at the same time opening the admission valve and closing the discharge valve of bed No. 2. When bed No. 2 is filled, this operation is repeated, the flow of tank effluent is diverted into bed No. 3 and the discharge valve of bed No. 1 is opened and its contents are allowed to discharge.

The construction involved the carrying out of 12,262 ft. of 9-in. pipe; 1,569 ft. of 12-in.; 1,349 ft. of 15-in.; 2,451 ft. of cast-iron pipe; 32 manholes and 982 junctions. The average depth of the sewers was 8 ft. 9 in. A great deal of the work was in sand charged with water involving constant pumping.

The cost of the works was as follows:

Sewers and pumping stations	$37,755
Pumping plant	3,185
Disposal works	13,079
Piling, etc.	5,119
Slag, 2,500 cu. yds. at $1.50	3,750
Automatic distributing gear	4,000
	$66,888

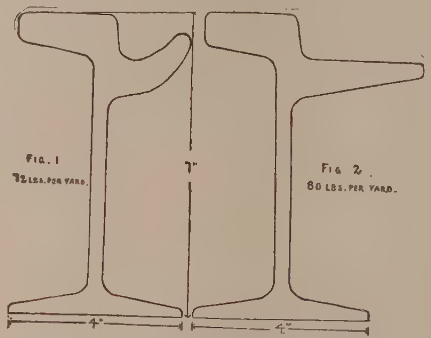
It was found after the slag had been in the beds some time about 10 per cent. of settlement took place. The works have been in operation since April and the effluent so far has been very satisfactory.

The Use of the T Rail in Cities.

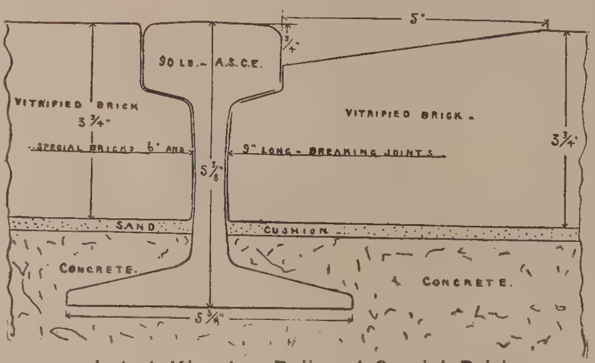
The oft-discussed question of permitting the use of T rails in cities was the subject of a paper read before the recent convention of the American Street and Interurban Railway Association by Vice-President C. Gordon Reel, of the Kingston Consolidated Railroad Co. He pointed out that in the horse-car days the equipment was so light and speeds so leisurely that the problem of a proper track was easy of solution. It was expected that wagon traffic of all kinds would follow along the car tracks and so city ordinances usually required that the street railroad companies make proper provision for the accommodation of vehicular traffic. With the introduction of electricity weights and speeds were increased enormously. The trend of development has been steadily to approach nearer and nearer to steam railroad standards. With the increase in weight of equipment and increase of speed, the grooved and girder rail sections soon demonstrated their inability to carry the car traffic without rapid deterioration. The inefficiency of these sections was due not to the light weight so much as to their unscientific design. The vertical web of the rail was usually directly under the flange of the wheel so that the weight of the car would be carried on a sort of projecting shelf. This unsymmetrical loading was more than the rails could stand. They pounded down rapidly at the joints and could not be held to gauge. The companies with which Mr. Reel is connected were unfortunate enough to build with 7-in. grooved and girder sections shown in the diagrams. These rails were structural wrecks at the joints long before they were worn appreciably.

In other cities similar sections have been used which overcome the inherent weakness in design by brute strength so to speak; that is, they are rolled in weights up to 150-lb. per yard, which would seem absurd to steam railroad men, especially in view of the very much heavier rolling stock used by the steam roads. It is self-evident that a proper section should not be inordinately heavy and should carry its load with no tendency to moving sideways, and furthermore that the track should stand solidly in place without having to strap the rails together every few feet. All T rails fulfill the first two requirements, but the standard steam railroad sections would seem to serve better than the high T sections in regard to lateral stability. Just what is gained by using a high T is hard to understand, still Mr. Reel is willing to concede that, in view of the experience in some of the larger cities which use this rail, there is a chance for an argument between high T sections and standard T sections. Personally he would prefer to pay more per ton for standard sections than for high T sections, although under ruling prices the high T cost considerably more per ton than standard T sections.

When it became necessary to renew the tracks in Kingston, Mr. Reel looked over the experience of other companies and concluded that the T rail was in every way more desirable than the grooved or girder rail and proceeded accordingly. To make sure he laid an experimental piece of track using 90-lb. Am. Soc. C. E. standard rail. This gave such good results that an order was placed for several hundred tons in 60-ft. lengths with a view to extending the construction. After the rails were delivered a bitter opposition was engineered by interests which formerly owned one of the roads and who seem to be sore because the present owners have been successful. It was argued that if, when they built the road, it was necessary to use an iron lip, unless the new owners used the iron lip, ruts would form along the track. The only difficulty about this point was that it was not necessary, in the first place, to use any iron lip because experience proves that there is no greater tendency for a rut to form along a T rail than along the outer edges of a grooved or girder rail. They also used letters from city engineers of New York, Brooklyn and Albany, stating that no T rails were used in those cities. This argument we easily answered by asking our opponents to produce letters from cities where T rails had been used. The fact that they produced letters from places where they had not been used was certainly no evidence against their use. After a lot of misrepresentation and personal abuse in the newspapers the company finally got consent from the city to lay T rails in two rather important streets with the stipulation that if, after the end of a year, the city authorities so desired we would remove them and substitute the old rails. Another feature which had to be overcome was a bill introduced in the legislature intended to prohibit the use of the T rail entirely in the State of New York. Whether or not this bill had any connection with the Kingston opposition or was merely a coincidence Mr. Reel was unable to say. In any event the bill was easily defeated and was never reported from the committee.



Rails Formerly Used at Kingston.



Latest Kingston Rail and Special Brick.

Since the installation of this 90-lb. standard construction in the two streets referred to, the company has been granted permanent permission without any restrictions to use this 90-lb. standard T rail in the most important streets in the city.

The construction first proposed has been amended as shown in the illustration, using a special form of brick outside the rail as well as inside. It will be noted that the brick on the inside goes up on the head of the rail to such a distance as to barely give room enough for the wheel flange. In this way the obstruction in the street will be much less than though the brick projected under the head of the rail and very much less than any form of grooved or girder rail. It is now standard practice to use only ordinary brick. On the outside the brick is merely laid flush with the rail, and on the inside it is tucked under the head.

The gist of the whole T rail matter seems to Mr. Reel to be that street railway tracks are beginning to be built to serve the companies which build them and the patrons of these companies, rather than every truckman who stubbornly insists on following the car tracks instead of staying out in the roadway where he belongs. If this driving along the tracks served any economic end it might be tolerated, but it does the truckman no good and interferes with the rapid movement and comfortable transportation of countless thousands of more important people.

Cinder Disposal in a Roundhouse.

A novel roundhouse with 44 stalls has been built at Dilworth, Minn., by the Northern Pacific Ry. Co. to improve the winter service of locomotives. The object in the design has been to avoid the necessity of sending a locomotive to the cinder pit after a run, for by saving this time the terminal expenses of an engine are reduced. When a number arrive at a terminal at about the same time on a cold day, the last to reach the pit loses much time before its fire is knocked out. At Dilworth the locomotive is run directly into the roundhouse, and does not go to the outside cinder pit unless every stall is occupied. There is a pit under each stall and in a depressed part of the pit containing water are two perforated pans about 72 x 30 in. in size to receive the ashes. The fires will be allowed to die out gradually before being dumped, or after they are cleaned they will be banked, thus saving coal wasted in the ordinary procedure. When the engine leaves the stall, an electric hoist traveling on an overhead track will run over the pan, lift it up and carry it to a cinder shed. This is merely one of the stall spaces into which cinder cars are run to receive the ashes from the pan. There are two pans in each stall so that two engines can use the pit before the ashes need be removed. It is expected that from $1 to $5 will be saved in this way on each engine handled at the new roundhouse.

State Forestry Work made great strides during 1906, according to the U. S. Forest Service. Ten States have State forest reservations, and in five of them the removal of mature timber from such public lands is now permitted, thus showing the growing appreciation of a fundamental principle of forestry. Over twenty States have forest officers.

Sinking the Detroit Tunnel Tubes.

The river section of the double-track tunnel under the Detroit River is 2,622½ ft. long, and has a maximum depth of 41¾ ft. from the roof to the surface. It is built in water subject to slight variation of level with an original depth of about 144 ft., and a maximum current of about 6 miles in the center of the river, which is navigated by a very large number of steamboats and sailing vessels. The tunnel is of steel and concrete construction as described in The Engineering Record of March 7, 1907, and is being built in a deep trench dredged in the bottom of the river.

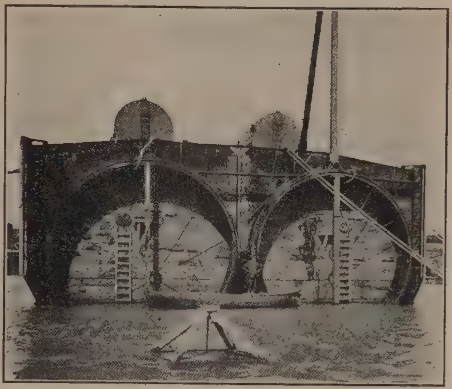
The tunnel is divided in ten equal sections, 262½ ft. long, for which the steel framework is assembled on shore, launched, towed to position, sunk in the trench, united by successive joints and concreted to form a continuous structure. The adoption of this method saved an initial difference of about $2,000,000 between the contract price for it and for the alternative plan of a tunnel constructed by ordinary shield driving methods. It is also built at an elevation of 15 ft. above the minimum necessary for the shield-driven structure and thus eliminates many hundred feet of shore approach tunnels, reducing the grades, and avoiding operation and construction expenses which, capitalized, would amount to about $2,000,000 more. This shows a balance of about $4,000,000 in favor of this construction which, in its details and in the method of execution is novel, although the idea of first constructing a tunnel and then sinking it below the surface of the water was proposed many years ago by the late John C. Trautwine.

Tubes at Commencement of Sinking Operations.

In this construction the fundamental principles are to avoid ordinary tunnel excavation, to reduce to the smallest practicable amount divers work, and to provide a permanent protective exterior concrete casing which first serves as a shelter in which the permanent tunnel can be built and inspected advantageously and economically under atmospheric pressure.

The finished structure consists of two parallel concrete tubes 20 in. thick, 20 ft. in internal diameter and 26 ft. 4 in. apart on centers. They have exterior steel shells, 23 ft. 4 in. in diameter, and are enclosed in a monolithic mass of concrete, about 56 ft. wide and 32 ft. deep.

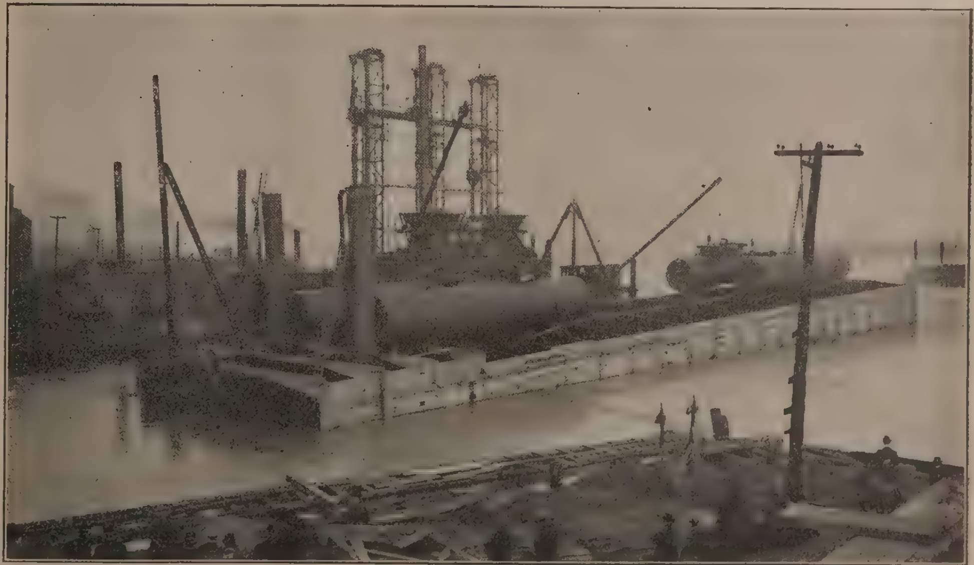
The steel tubes are built in sections 262½ ft. long and are connected by exterior transverse vertical steel diaphragms 12 ft. apart which are 55 ft. 8 in. long and 30 ft. 10 in. deep with their edges stiffened by pairs of flange angles. The vertical and inclined outer edges of the diaphragms are sheeted with horizontal planks permanently enclosing the tubes like the sides of a bottomless scow and serving, after the tubes are sunk, for the exterior walls of a mould to retain the concrete jacket and prevent the large loss that would otherwise accrue from its lateral extension to fill the open trench if it were deposited without a mould. The tubes, diaphragms and sheeting were assembled and completed on shore and launched like a ship, towed to the site, sunk to position in the trench, coupled together by divers, the exterior concrete deposited under water through tremies and the inside concrete steel tunnel rings will be constructed in the water-tight tubes thus provided.



Tubes and Sheeting as Launched.

On the Detroit side of the river the approach is now being constructed by ordinary tunneling excavation methods and about 700 lin. ft. of trench has been excavated in readiness to receive the steel and concrete construction of the submerged portion. The junction with the land tunnel is made in a slip, sheltered from navigation and from the river current where the original depth of the water was about 26 ft., and the excavation was made to a depth of about 45 ft. below the surface by means of a dipper dredge with a 2-yd. bucket working on 1:1 slopes in the hard blue clay. Below a depth of 45 ft., the excavation is continued with 1:½ slopes by means of a clam-shell dredge with a special 2-yd. bucket, designed by the G. H. Williams Machinery Co., Cleveland, O. The jaws of this bucket have a width of 12 ft. when opened and in the hard, tough clay encountered cut off a 6-in. layer from the upper surface and roll it up like a carpet as the bucket closes. The average capacity of the dipper dredge is about 2,500 cu. yd. in 10 hr., and of the clam shell about 600 cu. yd.

It was at first proposed to secure the vertical alignment and uniform bearing of the steel tubes by driving foundation piles in the bottom of the tunnel trench and cutting them off accurately at the required level. It was finally decided that the same result could be more satisfactorily obtained without pile driving by the use of steel grillages supporting the ends of the tubes on the bottom of the trench. Accordingly there are provided for each section of the tunnel two grillages 42 ft. long and 38 ft. wide made with two 12-in. longitudinal and twelve 12-in. transverse I-beams, framed together and web-connected with their top and bottom flanges flush. In each corner of the grillage there is riveted a short vertical 6x6-in. angle to which is bolted an 8x8-in. vertical timber 6 ft. long with a sharpened point, projecting 5 ft. below the bottom of the grillage.



Tubes Commencing to Tip.

Pin-connected vertical rods 1 in. square, in convenient lengths of about 20 ft. are detachably connected to the corners of the grillage and suspend it symmetrically in a horizontal position under the bottom of the concrete barge. As the latter is only 35 ft. wide, the ends of the grillage project beyond both sides and the vertical rods pass up between pairs of horizontal cantilever beams projected to receive them upon the deck of the barge. The upper ends of the suspension rods have long threads cut on them and the nuts engaging them take bearing on the cantilever beams and enable the grillages to be lowered accurately to position in the bottom of the trench.

Divers then descend and place on the square upper ends of the 8x8-in. vertical timbers a pile driver hammer running in special leads attached to the grillage. The hammer is then operated to drive the vertical post about 5 ft. in the bottom, bringing the grillage to the exact required level and thus providing for the accurate support of the tunnel tubes. Concrete is deposited around the grillage beams by the tremie tube, thus supporting them solidly and giving an extended bearing on the bottom of the trench to distribute the weight of the steel tubes and reduce the pressure to the proper unit values. Divers level off the top of the concrete so as to insure clearance below the upper flanges of the beams and the grillages are ready to receive the tunnel tubes.

The steel tubes are being built by the Great Lakes Engineering Works at their ship yard in St. Clair about 60 miles above the tunnel site. Each pair with its diaphragms and wooden sheathing, weighing in all about 800 tons are assembled and riveted up complete on several transverse supports, each of which contains four sets of loose timber blocking about 4 ft. high and is seated on ordinary launching ways inclined about 1:8 from the horizontal. The ends of the tubes are temporarily closed with solid wooden watertight bulk-heads and as the tubes are launched transversely the sets of blocking move down toward the water on the fixed timbers of the ways and when they reach the lower ends of the latter collapse successively until the tubes strike the water. This method of launching is a modification of that universally used in the ship yards on the great lakes.

After launching, a pair of horizontal longitudinal 10-ft. steel air cylinders 60 ft. long are temporarily attached to the top of each end of the pair of main tubes symmetrical with reference to them. A vertical access shaft 4 ft. in diameter and 32 ft. high is also attached at one end of each of the first pair of main tubes to serve as a manhole providing entrance to the interior after the tubes are submerged. In this condition the tubes have a draft of 4½ ft., with the diaphragms projecting 3 ft. farther down, and are towed 60 miles to the site and moored to pairs of anchors on the up and down stream sides. These anchors are of special design, built of steel and concrete, and weigh about 8 tons each, submerged.

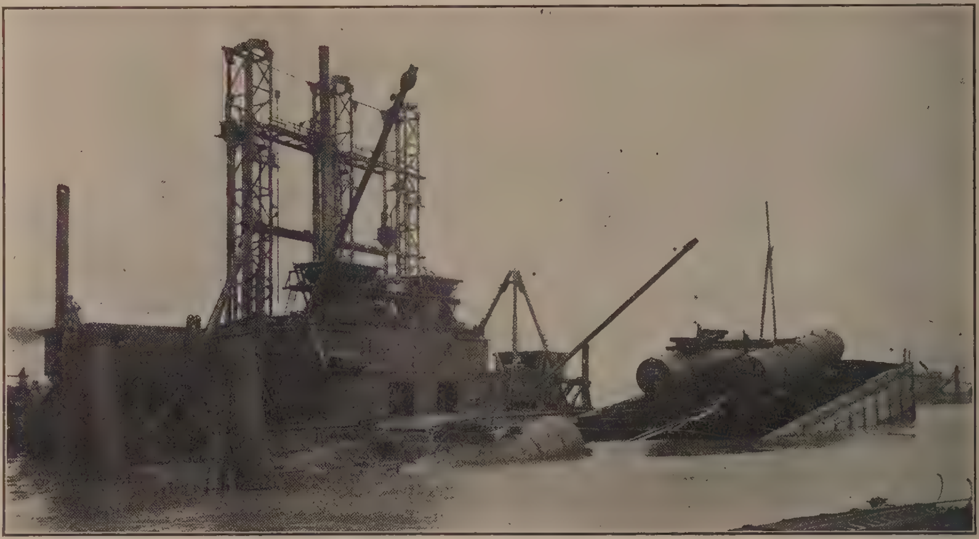
The first pair of tubes was moored in a slip protected at one end from the current, which at the other end had a velocity of only about 1 mile an hour. At each end of the downstream side of the tubes was attached a single 2-in. manila hawser led through a snatch block on the anchor and another on an adjacent steel buoy of 5 tons buoyancy and then supported on a line of buoys carrying it to the capstan head of a hoisting engine on the concrete barge moored alongside the tube.

The moorings on the up-stream side of the tube were the same except that the 1⅜-in. steel anchor cables were not connected to buoys, but led directly from the anchors to 8-part tackles rove with 2-in. manila line and operated by capstan heads of the same hoisting engines on the concrete barge. Provision is made for attaching four more sets of tackles and anchors to the up-stream side of the tunnel sections as they extend farther and farther into the river and the velocity of the current increases to 4 and 6 miles per hour. The mooring was found to be so efficient that the tubes could be adjusted quickly to within a very few inches of position by overhauling and slacking the lines.

As the first pair of tubes had to be sunk about 63 ft. special provision was required for locating them accurately under the surface of the water and was secured by providing at each end a riveted steel column about 50 ft. high temporarily seated on the center line on top of one of the tubes at each end and thoroughly braced by diagonal rods and struts. The column was conspicuously painted with alternate red and white marks, giving an accurate vertical target for leveling as well as centers for alignment.

The 35x155-ft. concrete barge 10 ft. deep was moored alongside the tubes to serve as a tender and its two 65-ft., 8-ton derrick booms were found very useful in handling the tubes and for various auxiliary services.

The tops of the shore ends of the first pair of tubes are provided with a seat for the cofferdam which will be sunk on it to make connections with the adjacent ends of the shore tunnel. Each tube is provided at the quarter points of its length with an inside removable wooden transverse vertical diaphragm reaching from the center of the tube to the top and forming a sort of trap which when sealed by the water rising in the tube as the latter is submerged, prevents the air from moving freely from one end of the tube to the other.



Tubes near Maximum Inclination.

At 2.53 P. M., October 1st, men stationed on outside platforms, bracketed to the bulkheads in the ends of the tubes, opened four 14-in. valves in the bottom of the tubes allowing the water to enter them as the air escaped through openings provided for the purpose.

The tubes commenced to sink very uniformly and steadily at the rate of about 4 in. per minute until they were about two-thirds submerged when the extra weight of the access tubes, which had an unbalanced effect of about 24 tons, caused them to pitch downward more at that end.

This movement, gradual at first, was clearly perceptible at 3.53 P. M., and increased more rapidly thereafter until at 4.02 P. M., the river ends at the shore end air cylinders were partly submerged, and at 4.10 P. M., their upper ends were scarcely half way above the water. About this time their buoyancy began to overcome the unbalanced load of the tube and as the latter gradually righted themselves to a horizontal position, the shore end air cylinders ascended and the river end cylinders descended until at 4.37 both of them assumed the same horizontal position with their upper surfaces about 10 in. out of water.

The main tubes and their diaphragms and sheathing were thus floating in perfect equilibrium below the surface of the water and the efficiency of the air cylinders and the accuracy of their proportioning was abundantly demonstrated. When they were designed it was uncertain whether the sheathing would be made of hard or soft wood and a considerable discrepancy in weight, which might be expected to vary from 36 to 60 lb. per cubic foot was thus encountered and was provided for by the volume of the air cylinders. Green maple planks which weighed about 60 lb. per cubic foot were finally used for the sheathing and the air cylinders had to sustain the maximum weight. The inlet valves were closed and as it was growing late the tubes were left moored in position over night.

Before the tubes were sunk timber cradles were built on the upper surfaces of their air cylinders at both ends and on each of them was set a 6-ton counterweight made with two cross tiers of I-beams bolted together in a convenient manner. Each of these counterweights was provided with a bridle attached at each corner and secured to the hoisting tackle on one of the derrick booms of the concrete barge alongside.

On October 2d, the inlet valves in the bottoms of the air cylinders were opened and water enough admitted to cause the cylinders to be almost entirely submerged. The boom tackles were overhauled allowing enough additional load from the counterweights to be applied to overcome their remaining buoyancy, and slowly sink them, followed down by the partly supported counterweights. Evidently this motion could be arrested at any moment by hoisting on the tackles which would cause the tubes to rise upward.

During the sinking the maximum lateral displacement of the tubes from their center line was about 2 ft. When they were within a few inches of the bottom their vertical motion was stopped and they were easily set by adjusting the mooring tackles to within 2 in. of their required alignment. The tubes were allowed to sink to bearing on the steel grillages and sufficient water was admitted to the air cylinders to give a reaction of about 10 tons, under which it was very easy to pull them with the mooring tackles until their position was exact.

The total time required for filling and submerging the tubes was 1 hr. 43 min., and the computed time was 1 hr. and 45 min. Sinking the tubes from the surface of the water to their position on the grillages occupied about 30 minutes. The work was done with a total force of about 30 men, and was considered so satisfactory that no changes have been planned for the next pair of tubes which it is expected will be sunk before Nov. 15.

Soon after the tubes were seated on their grillages, the concreting underneath and around them was commenced and the concrete was deposited by the three 12-in. tremie tubes 80 ft. long which are suspended in three square towers on the concrete barge and can be raised vertically clear above the surface of the water or lowered to rest on the bottom of the trench. Sand and gravel is dredged at Port Huron, 75 miles away, and delivered by scows to the concrete barge where it is unloaded by clam-shell buckets and deposited in elevated hoppers discharging on inclined screens which separate the sand and gravel and deliver them by gravity to hopper bottom bins with bottom gates through which they can be run into the charging hoppers of one 1-yd. and two ⅔-yd. cubical concrete mixers.

Tunnel Tubes in Position on Grillages in Trench, with Tops of Access Shafts Visible.

Bags of Alpha and Peerless brand Portland cement are delivered by a belt conveyor to the concrete charging platform and the mixed concrete is discharged from the machine into tilting buckets hoisted from 5 to 70 ft. in the tremie towers, to which are bolted guides for the bucket elevator. At the required height the bucket is tripped by a trigger which causes it to dump directly into the funnel at the top of the tremie tube, after which the bucket automatically reverses and is lowered for another batch and so on.

The tremie tubes were proportioned to discharge their contents within 5 minutes after it leaves the mixing machine so as to avoid all danger of set in the concrete before being placed, and the dimensions thus obtained have been found very satisfactory and have enabled the concreting to progress at the rate of 30 to 36 cu. yd. per hour for each tremie, giving very excellent results in water 72 ft. deep. This is considered notable since it is believed to be the first instance in which concrete has been successfully deposited by tremies at a depth of more than 45 ft.

All danger of breaking the seal at the foot of the tremie tube is avoided by the use of a telltale which constantly indicates the height to which the concrete rises above the foot of the tube on the outside. This consists of a 12-in. ball with a specific gravity a little greater than unity, which is suspended alongside the tremie tube by a wire passing through a vertical pipe and led around a sheave at the top of the tube to a counterweight and index which constantly registers the position of the ball on a scale alongside. It is found that the height of the concrete outside immediately adjacent to the tube varies from 6 to 12 in. above the bottom of the tube and that the moderately wet concrete flows almost horizontally about 10 ft. each way from the bottom of the pipe.

The water will be pumped out of the tunnel tubes by an electrically-driven Gould centrifugal pump in the bottom of each at the foot of the access shaft, which discharges through a 10-in. vertical pipe carried up outside to avoid obstructing the shaft.

After the tubes are firmly settled on their grillages, water is admitted into the air cylinders, reducing their buoyancy enough to relieve the strain on their connections to the tubes. They are then disconnected by divers and air being forced into the cylinders the water is expelled and they regain their buoyancy, rise to the surface and are installed on another set of tunnel tubes and so on.

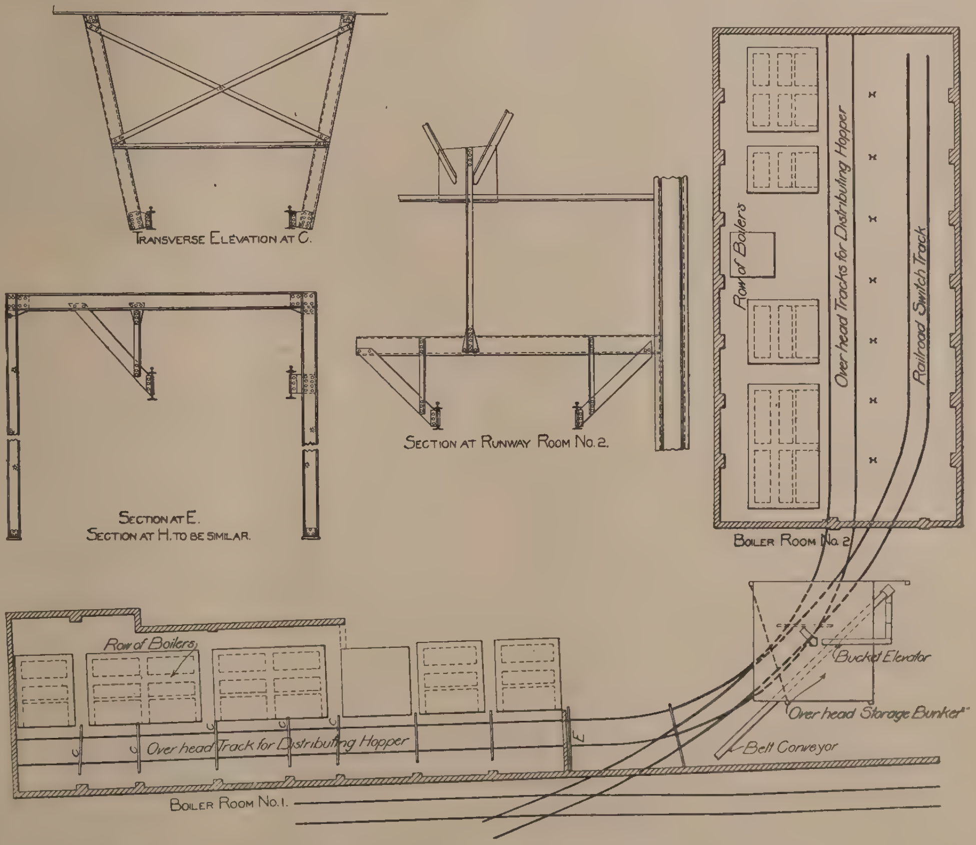
The tunnel is being built under the supervision of Mr. W. S. Kinnear, chief engineer of the Detroit River Tunnel Co., by Butler Bros.-Hoff Co., of New York City, under the personal supervision of Mr. Olaff Hoff. The design for the subaqueous section was made by Mr. Olaf Hoff, of the contracting firm, and was approved by the board of engineers consisting of Mr. W. J. Wilgus, Mr. H. A. Carson and Mr. W. S Kinnear. The Dunbar & Sullivan Dredging Co. are sub-contractors for the dredging.

An Unusual Coal and Ash-Handling Equipment for a Power Station.

The extensive by-product works of Armour & Co. are nearly all centered in a group of large factory buildings at Thirty-first and Benson Sts., Chicago. The great quantity of heat and power required by many of the processes in the various buildings is all supplied from a single central station, which replaced a number of separate mechanical plants in the different buildings when it was completed about three years ago. This station is specially designed to meet the many unusual demands for heat and power brought about by the by-product processes, such as the manufacture of soap and glue. Live and exhaust steam for heating are piped to the different buildings, but the mechanical equipment in all of the latter is driven by electric power generated in the central station.

The central station is contained in three buildings, a generator and engine house and two boiler houses, all of which are interconnected. The general arrangement of these buildings is shown in one of the accompanying illustrations. The two boiler houses form two sides of a hollow square, with the generator and engine house inside this partially enclosed space. As is shown in the plan, the adjacent ends of the boiler houses do not come together, but a connecting building has been erected over the space between them.

These houses contain thirteen Stirling water-tube boilers with a capacity of about 5,000 h.-p. Part of the boilers were formerly hand-fired, and the remainder were equipped with chain-grate stokers, which were also supplied by hand. Coal was delivered on a railroad siding that extends along the side of one house and on a second siding extending the full length of the other house, directly in front of the boilers. It was shoveled from cars on these sidings to firing floors in front of the boilers and from the latter into the furnaces. The ashes were hauled out of the basement in wheelbarrows operated on inclines extended to the firing-room floor. When the de-


Transverse Elevation at C.
Section at E.
Section at H. to be similar.
Section at Runway Room No. 2.
Row of Boilers
Overhead Tracks for Distributing Hopper
Railroad Switch Track
Boiler Room No. 2
Bucket Elevator
Overhead Storage Bunker
Belt Conveyor
Row of Boilers
Overhead Track for Distributing Hopper
Boiler Room No. 1.

Plan of Boiler Houses and Coal-Handling Equipment, Armour & Co.

cision was made to install mechanical equipment for handling the coal and ashes, arrangements were also made to equip the hand-fired boilers with chain-grate stokers, in order to eliminate as fully as possible all manual labor in the coal handling. The boilers are therefore all served by the new coal-handling installation, which is designed so it is common to both houses.

Essentially, the coal-handling equipment consists of a large overhead storage bunker, in the connecting building between the two boiler houses, and a hopper, carried by a crane traveling on a track suspended from the roof of this building and of the two houses, in which the coal is delivered to the boilers. The ashes are handled from a space under each boiler furnace to a storage hopper over the siding by a pneumatic exhaust system in which the only moving part is an exhaust fan.

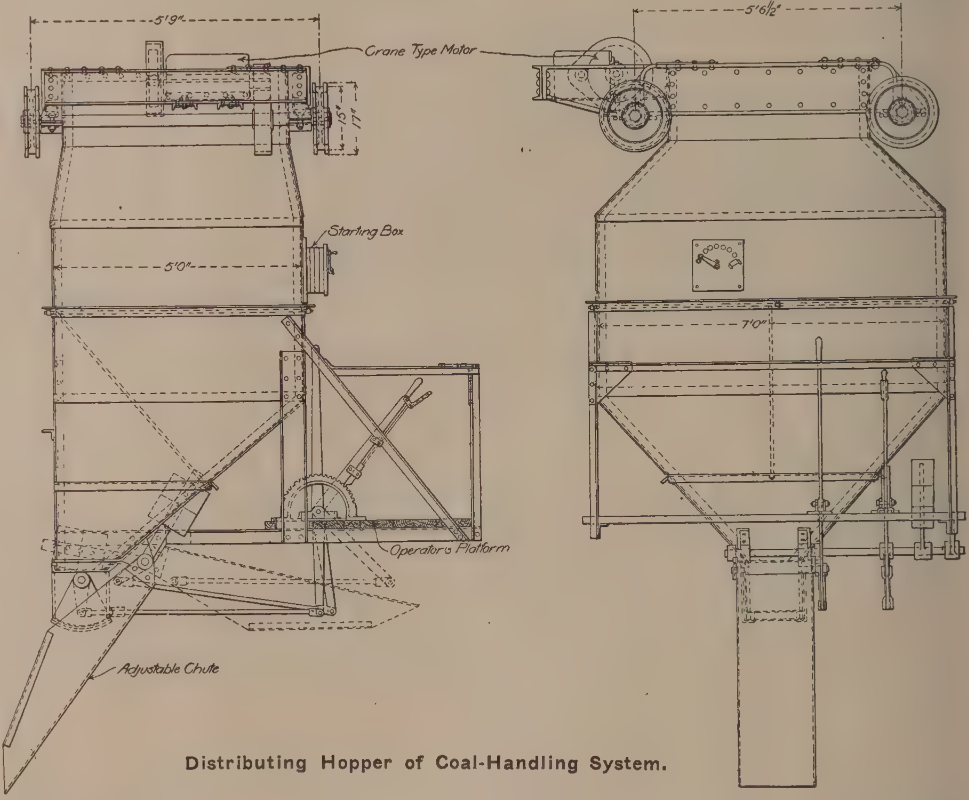
The coal is at present delivered into the connecting building between the two houses on cars on the railroad siding, and is shoveled from these cars on a horizontal belt conveyor, 55 ft. long between the end pulleys. Coal can also be shoveled through windows in the side of the connecting building on a second belt conveyor along that side which delivers to the one along the track in the building. The siding is on a 35-deg. curve at the latter conveyor, so the apron between the conveyor and the sides of the cars had to be built to meet this condition. The coal is delivered from the end of this conveyor through a crusher into the boot of a bucket elevator, or directly into the elevator boot by by-passing the crusher. The bucket elevator, 65 ft. 7 in. between the sprockets, is practically vertical, and is driven by a 7½-h.-p. motor, which also drives the belt conveyors. The elevator delivers the coal into the overhead bunker at one side of the latter, a horizontal run of a broad link chain serving as a distributer to carry the coal across the bin as it piles up on that side.

While this is the present method of filling the storage bunker, arrangements have been made to install a clam-shell bucket on a trolley on the roof of the building so the coal can be hoisted to the bunker from cars on the track at the side of the building by this bucket. As screenings are burned almost exclusively under the boilers in the two houses, this arrangement can be used, except when run-of-mine coal is received and has to be passed through the crusher. The men now required in shoveling coal from the cars to the conveyor belt can thus also be eliminated.

The overhead storage bunker is 32 ft. square in plan at the top and has a capacity of 400 tons. It is carried by four steel columns, two of which are each at a corner, while the other two had to be placed at a considerable distance from their corners to provide space for the switch track and the belt conveyor. The bottom of the bunker is built as a hopper with an undercut gate controlling the outlet.

The traveling hopper in which the coal is distributed from the storage bunker to the boilers has a capacity of 7 tons and is supplied from the undercut gate at the bunker. The four-wheel crane which carries this hopper runs on an overhead 5 ft. 9 in. gauge track. This track extends the length of the single row of boilers in each boiler house, a 55-ft. radius curve in the building between the ends of the two boiler houses connecting the track on tangent in the latter. The track consists of two 25-lb. T-rails carried by 15-in. I-beams. These beams had to be suspended in different ways, as the roof of one boiler house is carried by steel rafters, while the other boiler house roof is on steel trusses designed to carry overhead bunkers, and in the connecting building special supports were required.

The sides and ends of the distributing hopper had to be converged at the top, in order to permit the four-wheel truck carrying the hopper to be shortened sufficiently to travel around the 55-ft. radius curve without difficulty. The truck is built of structural steel shapes and carries a doube-flange traveler wheel at each corner, the pairs of wheels being 5 ft. 6½ in. apart on centers, which is the same wheel base as used for the trucks of heavy interurban railway cars. The truck passes readily around the curve in the track on which it travels, the hopper, in fact, being loaded from the overhead bunker while on the curve. The hopper is propelled along the track by a 9-h.-p. crane type motor, geared in the ordinary manner to the axle of one pair of wheels. This motor is designed to operate at about 850 r.p.m., thus giving the hopper a traveling speed along the suspended track of about 260 ft. per minute. The motor is controlled by a starting box mounted on one side of the hopper where it is within reach of an operator on a platform carried on that side of the hopper. Two of the traveling hoppers are provided, one for each boiler house, but a single hopper is used to supply coal to both of the latter and the second one is held in reserve.



Distributing Hopper of Coal-Handling System.

The operator on the platform carried by the hopper controls the undercut gate on the storage bunker, and also an undercut gate on the hopper, by a lever for each gate at the platform. As the gate on the hopper is opened and closed, the lever operating it simultaneously lowers and raises, respectively, a hinged chute extending to the charging hoppers of the stokers. These hoppers of the stokers have been enlarged to hold two tons each. When the distributing hopper reaches a stoker to be supplied with coal, the chute is lowered and the distributing hopper moved slowly along the track until the stoker hopper is filled, without spilling any coal. The distributing hopper is then moved along to the next stoker to be supplied. Working in this manner one distributing hopper has demonstrated that it can easily supply coal to the thirteen boilers, and give the man who operates it sufficient time to operate the pneumatic ash-handling system.

The coal-handling equipment was designed by Messrs. Orton & Steinbrenner, commercial engineers, of Chicago, and was manufactured by the C. O. Bartlett & Snow Co., of Cleveland, Ohio.

A tunnel, 8 x 8 ft. in cross-section, was built the length of both boiler houses, under the floor in front of the boilers, to provide in each case for a 10-in. pipe header of the ash-handling system. Each header is connected to the ash pit of each of the boilers in the row served by it. The 10-in. headers both terminate in a specially-constructed separator placed close to the roof in one of the boiler houses. An 18-in. pipe leads from the separator down to a 40-in. exhaust fan on the floor below and thence up to a free exhaust above the roof.

The connection to each ash pit from the header is ordinarily closed; when ashes are to be removed from a pit, a plug in a tee on the connection is removed and a small hopper is inserted in order that the ashes may be pulled into the connection readily. The two headers are connected with the separator on diametrically opposite sides near the top. They are both extended into the separator by an elbow with the open end down, so the ashes are discharged to the bottom of the separator. The connection between the fan and the separator is taken out at the top of the latter. With this arrangement the inflow of ashes and air is not only directed to the bottom of the separator, but also has a much higher velocity than the upward outflow of air, due to the relative cross-sectional areas of the inlet pipes and the separator. A spray of water, directed from a nozzle in the top of the separator, is continuously played on the ashes as they enter, which, together with the difference in velocity between the inflow and the outflow, results in the ashes being completely deposited in the bottom of the separator. The ashes are drawn from the separator through a pipe controlled by a continuous discharge gate of the revolving pocket type. This gate is always sealed to prevent the admission of air and is turned by a small motor. A storage bunker, with a capacity of 60,000 lb. of wet ashes, is placed immediately under the separator, where its contents can be discharged through an under-cut gate, operated from the boiler room floor, into a car on the switch-track on that floor.

This installation of pneumatic ash-handling equipment has operated with complete satisfaction during the brief period it has been in service. The Economic Engineering & Construction Co., of Chicago, by which it was designed and installed, has also furnished the same equipment to a number of other power plants, in which it is operating with surprisingly excellent results. A velocity such as is furnished for the equipment that has been described, by the fact that is a part of the latter, will lift paving brick from the ash pits and deliver them to the separator. In fact, in a test of an installation of this kind recently made by the engineering department of the Western Electric Co. bricks were carried 200 ft. in a horizontal pipe and elevated to a separator 110 ft. above the ash pits.

It is expected that the ash-handling system in this plant will not have to be operated more than four out of the twenty-four hours to handle all of the ashes produced by the furnaces of the thirteen boilers. Following the practice that has been evolved in operating previous installations, the equipment will probably be operated for short intervals at a time, as the contents of an ash pit can be removed very quickly. The man who operates the coal distributing hopper will therefore also be able to operate the ash-handling equipment, since the latter requires only a small amount of labor involved in pulling the ashes into the portable hopper placed on the connection to the ash pit.

The central station in which the installations that have been described were made is operated under the direction of Mr. C. W. Brown, chief engineer of the station and of the works supplied with power by it.

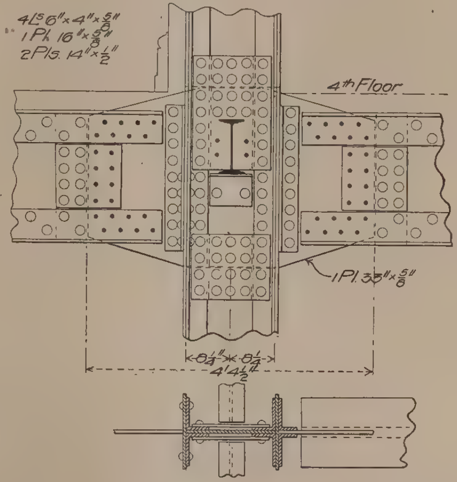
Temperature Changes in Pipe Tunnels.

Cracking from temperature changes has not occurred in a 750-ft. concrete subway having a 350-ft. branch, in which steam, water and air pipes have been run, according to a committee report to the recent convention of the Association of Railway Superintendents of Bridges and Buildings. The tunnel is 4½ ft. wide, 3 to 5½ ft. deep, with side walls and bottom 12 in. thick and a 4-in. cover slab of reinforced concrete, which is used for trucking materials between different buildings. No provision for expansion was made in the walls or bottom, but joints were made in the cover by cutting through the concrete at every 5-ft. joint in the sheets of reinforcement before putting on the top surfacing. The temperature in the tunnel has ranged from 110° to 175° during the last three years, during which no cracks have been observed in the concrete.

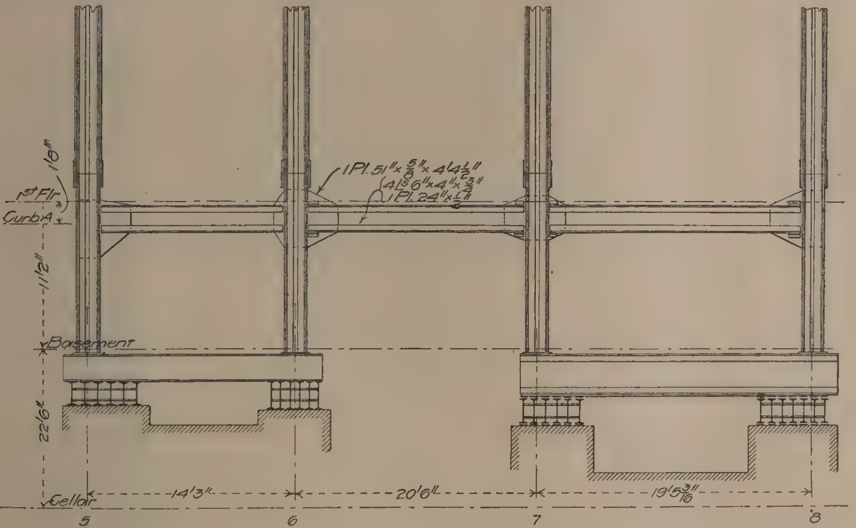
A STEAM DRIVEN TURBO-GENERATOR of the Curtis type, having a normal capacity of 20,000 h. p., has been ordered from the General Electric Co. through the Pacific Coast office.

The German-American Insurance Building, New York.

The new steel cage office building for the German-American Insurance Co. is a 20-story and basement building, about 273 ft. high from the curb to the roof, located at the intersection of Liberty St. and Maiden Lane, adjacent to the congested banking district in lower New York. It occupies a trapezoidal area, about 19 ft. wide at one end and 62 ft. at the other end, with fronts of 128 ft. on Liberty St. and 137½ ft. on Maiden Lane. The superstructure is supported on twenty rectangular concrete piers, carried down to hardpan about 40 ft. below the curb in wooden pneumatic caissons. At the wide end of the lot there are two very large piers, each supporting 4 columns; at the narrow end there is a single full-width pier, supporting four columns, and all intermediate columns are each supported by separate piers. The column loads, of a maximum of 1,800,000 lb., are transmitted to the concrete pier through I-beam grillages, which extend the bearings sufficiently to reduce the unit pressure to 30,000 lb. per square ft. on the concrete.



Connections to Column 21 at Fourth Floor.



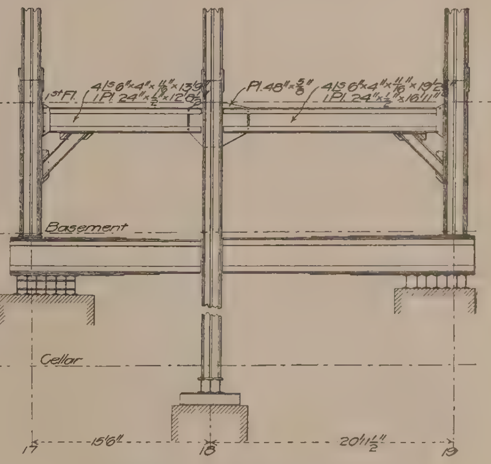
Transverse Section at Wide End of German-American Insurance Building.

The largest loads carried by the intermediate columns are 940,000 lb., which are transmitted from the column base to the grillage through three distributing beams 5½ ft. long, each of which is made with a pair of 15-in. 45-lb. channels, riveted together back to back to provide thicker webs for the heavy shear than could be secured in single I-beams. The channels are seated across the top flanges of eight 12-in. 35-lb. I-beams, 5½ ft. long, connected together with six tie rods and gas-pipe separators. The beams are set in the usual way on a ¾-in. layer of grout, and the interstices between their webs are filled with concrete, which is extended to enclose them with a minimum thickness of 3 in.

At the ends of the building there are three groups of 4 columns each, seated at the corners of the piers on grillages symmetrically arranged so that the center of gravity of the system corresponds with that of the pier. As the centers of all wall columns are located 22 in. from the building line, it is impossible to make them concentric with the grillages or with the piers, and they are seated on the short arms of transverse cantilever girders, with their fulcrums on the center lines of the grillages, which in turn are either central or symmetrical with the piers.

At the narrow end of the building the three last transverse bents of the framework are made with two columns each, which are seated at the opposite extremities of double cantilever girders, the upper flanges of which are 3½ in. below the basement floor line. In these bents the columns are from about 16 to 24½ ft. apart on centers, the respective girders are about 4 ft. longer over all than the distance between centers of the columns, and the distances between centers of their bearings on the grillages is about 2 ft. less than the distances between centers of columns, thus making each girder consist of two short cantilever arms connected by a long anchor arm. Each girder is composed of two independent plate girders, about 3 ft. deep, with single or double cover plates on their top and bottom flanges.

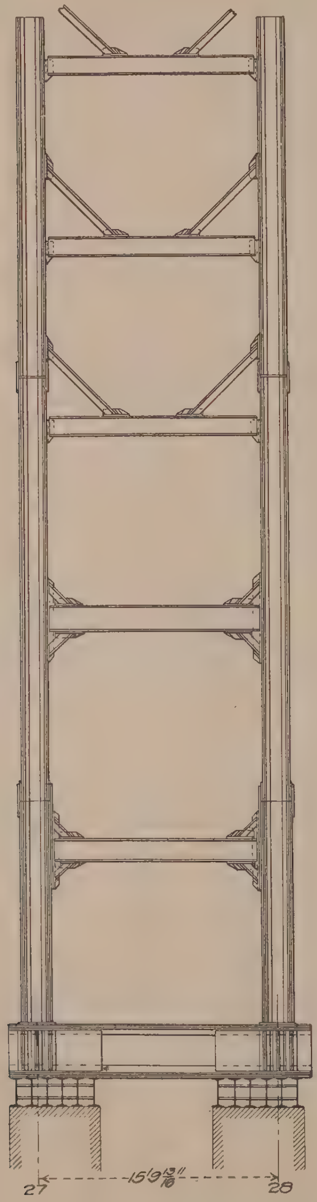
Where the building is wider each transverse bent contains three or four columns, from about 14 to 23 ft. apart on centers. In the wide bents the transverse cantilever girders are not continuous across the full width of the building, but are arranged in two different ways, both of them corresponding to the construction already described over the wall piers, but varying at the inner end. In the three-column bents the inner ends of the girders abut against the opposite faces of the interior columns and are field riveted to them several feet above their bases, which are carried down to a lower level than are the wall columns. This arrangement conforms to the construction of the interior piers, with their tops 3 or 4 ft. below the cellar floor, and of the wall columns, with their tops correspondingly close to the basement floor, which is 26 ft. above the cellar floor.



Intermediate Transverse Section.

In some of the four-column bents in the wide part of the building the cantilever girders in the side panels are like those already described in the three-column bents, with the inner ends connected to the exterior columns between the basement and cellar floors, and with the girder essentially continued across the center panel by means of a 20-in. I-beam, with its top flange flush with the top flanges of the girders. Other four-column bents are made with the cantilever girders quite symmetrical about their center line and supporting the interior columns on their top flanges the same as the wall columns. In this case the interior columns are not connected, and there is no floor beam across the center panel below the first floor above the top.

It was assumed that the mass of the building, the stiffness of its walls and the rigidity of the regular connections are sufficient to resist the horizontal stresses in longitudinal planes produced by the assumed wind load of 30 lb. per square foot. Transversely, however, the building is so narrow that special wind bracing was introduced in every bent, and the details were arranged to facilitate shop riveting, to eliminate as much as possible field riveting, to cause the minimum obstruction to the windows and to conform with the requirements of the general architectural treatment.

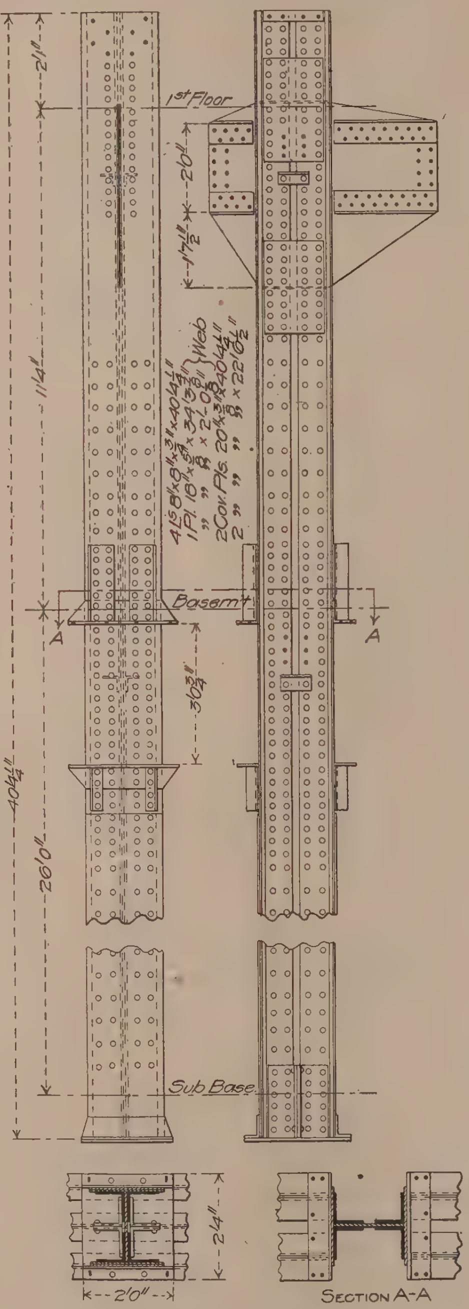


Wind Bracing, Narrow End.

In all panels there are horizontal struts just below the floor line, which increase in depth and cross-section from the top downward. All of them are knee-braced to the columns at both ends; in most cases the knee-braces are formed by deep, vertical gusset plates integral with the column web and projecting beyond both top and bottom flanges of the horizontal struts. In some cases, however, these are replaced by entirely detached knee-braces.

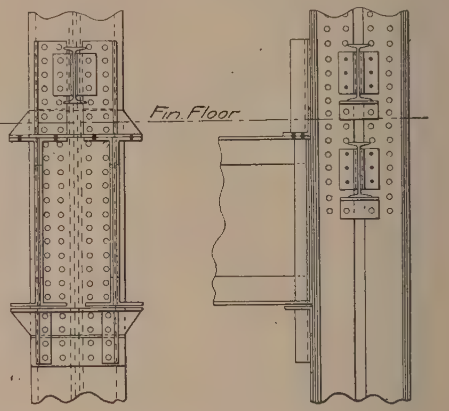
In the end panel the transverse struts are omitted above the 15th floor, and from the 15th floor to the 3d floor, inclusive, the struts are made with a pair of channels having vertical connecting angles to the columns and provided on the upper side only with knee-braces, made of a 6x3½-in. angle. At the first and second floors the struts have short detached angle braces on both top and bottom flanges, which are connected to the columns through the same vertical angles that engage the webs of the strut.

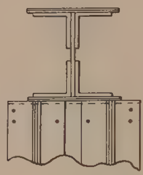
All other transverse bents have channel struts without knee-braces at the 16th and 17th floors, and below that have struts made with pairs of plate girders and solid gusset plate knee-braces to both top and bottom flanges, except in some cases at the first floor, where in one two-column bent and one three-column bent the lower flange only is knee-braced with pairs of 12-in. channels. The minimum plate girder struts are made with four 3x3x⅜-in. flange angles and one 24x⅜-in. web plate. The maximum have four 6x6x13-16-in. flange angles, and one 24x½-in. web plates, or four 6x6x13-16-in. flange angles, and a 36x½-in. web plate, and are connected to the columns with 66x⅝x35½-in. gusset plates.

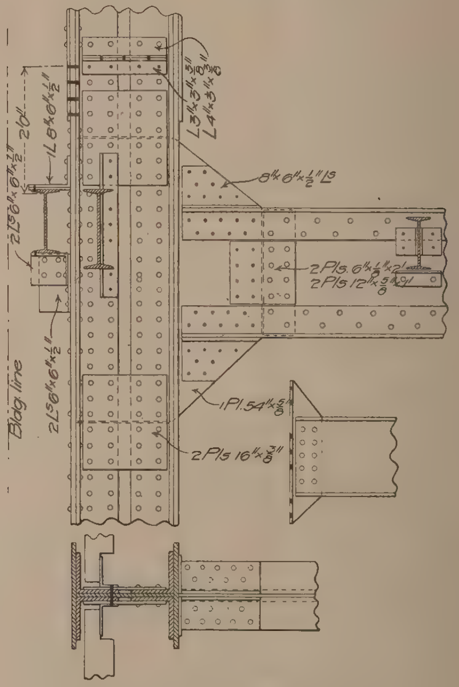


Lower Section of Typical Column 18.

The walls in the street fronts of the building are carried at every story on I-beams, bracketed out from the face of the columns and abutting on the center lines of the latter. They are 15 in. deep, except at the third floor, and in one panel of the first floor, where they are 20 in. deep. Above the second floor all of them are knee-braced at both ends with single 6x3½x⅜-in. angles at 45 deg. with the top flanges. Below the third floor all of these knee-braces are omitted, except in the end panels and in one special first floor panel, where there are also two long knee-braces to the center point of the second floor wall girder. In the lower end panels the knee-braces are made with 12-in. channels, and in the basement the lower flanges of the wall girders are braced with single 6x3½ in. angles.



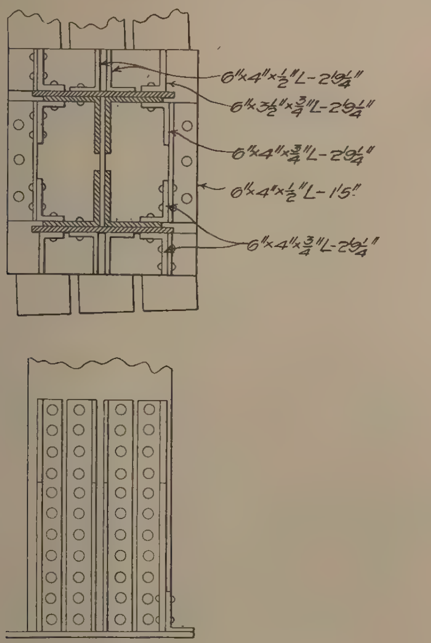

Connection of Grillage Girder to Interior Column.



Wind Brace Connections.

All of the columns have I-shaped cross-sections, made up with a web plate and four flange angles, with or without cover plates, as required for different loads. At the floor points the regular column webs are cut to clear short sections of wider web plates, which are shop riveted between the column flanges and project beyond them far enough to provide gusset plates punched for field rivets in the ends of the transverse girder braces. Where the braces are plate girders their webs are cut to clear the column webs and are spliced to them with cover plates, while the flange angles project across the column webs, and in some instances have additional connection angles riveted to their outside flanges to develop the full strength of the angles.

The details of the wall columns are clearly shown in the engravings of their connections with the transverse braces. They are of simple construction, spliced just above floor level with jaw plates, shop riveted, to the lower ends of the upper sections of the columns and with horizontal angles riveted to the webs of both columns. Columns 23 and 24 are seated on the top flange of the basement cantilever girder, to which they are connected by rivets through horizontal transverse flange angles at the lower edges of extended web plates, reaching across the full width of the girder. Two pairs of 8x8-in. vertical angles, back to back, are riveted to the lower end of the web and faced to bearing on the top of the girder so as to thoroughly distribute the column load.

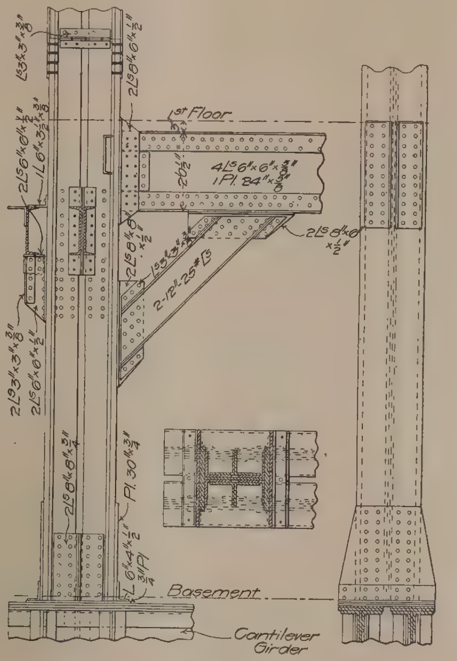


Base of Column 2.

Columns No. 10 and 11 receive the ends of the basement cantilever girders one story above their pedestals, and the heavy upward reactions are transmitted to them through double rows of rivets in 2 vertical 8x8-in. angles, riveted to the inside of the webs of the girders. Transverse angles riveted to the column face also form reaction seats for the upper flanges of the girders and are reinforced and their loads distributed somewhat through the column by 8x8-in. vertical angles, faced to bear against their horizontal flanges. The lower flanges of the girders are also seated on horizontal shelf angles, riveted to the column faces and reinforced with small vertical angles milled to bearing on their outstanding flanges in the usual manner.

Column No. 2, in the party wall at the end of the building, is seated directly on a group of three distributing I-beam girders. It has a wide base extended to cover the full width of the I-beams and distribute the load upon them and stiffened by 12 vertical angles, riveted to the extended side plates at the base of the column in pairs back to back on the center line of the web and at the corners of the base plate. The interior columns are of very simple construction, with horizontal shelf angles engaging the top and bottom flanges of the connected girders and vertical web-connection angles for the I-beam floor beams, which are also, for convenience in erection, seated on bottom flange shelf angles.

Throughout all the floors the I-beams are placed longitudinally and are from 4 to 5 ft. apart, with spans of about 18 ft. In the basement they are connected directly to the transverse cantilever girders, with the top flanges of the beams flush with those of the girders. In the basement they are generally single 12-in. 31½-lb. I-beams, except in some cases where they are made with a pair of 12-in. channels riveted together back to back, in order to provide spaces between their webs for the connection of hanger plates. The upper floor beams are nearly all 10-in. 25-lb. I-beams, connected directly to the columns at panel points and intermediately web-connected to the transverse girders which serve as wind braces, as previously described.



Detached Knee-Braces at Columns 23 and 24.

Messrs. Hill & Stout are the architects and Post & McCord are the general contractors for the steel work.

Foundation Reconstruction of unusual difficulty has been carried on for some years at Winchester Cathedral, in England, under the direction of Mr. T. J. Jackson. The original Norman church was built in the eleventh century on the edge of a peat bog 7 ft. thick, covered by a bed of chalky marl washed down from the surrounding elevations. The early builders encountered water at a depth of about 10 ft. and were unable to go deeper, so they drove some short oak piles and laid their foundations on them. When the presbytery and first bay of the lady chapel were undertaken, at the end of the twelfth century, it was necessary to go out into the bog farther. The water kept the builders from excavating below 10 ft., and at that depth they constructed a platform of trunks of great beech trees. This foundation has been gradually sinking, the vaults have been disturbed, and this part of the building has split off from the Norman portion. These sinking walls have been underpinned, down to a gravel bed underlying the peat at a depth of 16 ft., by concrete foundations put in place with the help of divers, who were employed in order to avoid the danger of settlement attending any attempt to pump water from the peat. The older Norman portions of the cathedral are now being partly underpinned in the same way, but other necessary repairs, such as iron ties to hold together some of the old walls must be deferred until more funds can be raised.

Removal of Manganese from Deep Well Water.

The "Journal für Gasbeleuchtung und Wasserversorgung" for Aug. 17, 1907, describes an interesting experience with manganese in the water supply of Arad, in the southern part of Hungary, where Rudolf Hajek is the director of waterworks. The city lies at an elevation of 348 ft. above the sea, and like others in that region suffers from a lack of good drinking water. In 1895 some test wells were driven in the diluvial strata to a depth of 328 ft., and assurance was given by the Municipal Chemical Institute, after having analyzed the water, that a good supply, satisfactory in quality, could be obtained at a depth of 138 ft. Accordingly works were built to take the water from wells at this depth. Although the chemical analyses had shown that the water contained only slight traces of iron, with no mention at all of manganese, the builders, Messrs. Hughes & Lancester, of London, advised that the water be aerated and filtered in order to prevent incrustation of the pipes. Sufficient aeration was obtained from the compressed air used for lifting the water, and the Fischer system of sand filtration was installed.

The wells, which were 9 to 12 in. in diameter and 132 to 138 ft. deep, were sunk in a line at right angles to the direction of the flow of the underground water. By means of compressed air, at 3.5 atmospheres, the water was lifted at the rate of 600,000 to 720,000 gal. per day. 1.5 cu. ft. of air at atmospheric pressure being required for each cubic foot of water. From a small receiving reservoir into which the water was thus pumped, there was a gravity flow to the filter beds. The filtered water was collected in a pure-water reservoir, holding 16 to 24 hours supply, and from this reservoir the water flowed by gravity to a pumping station, 300 ft. distant, where high-duty pumps sent it through two 14-in. force-mains 23,000 ft. long, to the distribution system of the city.

The works were put in service about the end of 1896 and for a number of months operated without trouble, but at the end of the first year the water drawn from the taps began to have a yellowish-brown color, which was especially marked whenever the circulation in the pipes was increased by sudden draft occasioned by the use of water for street sprinkling, fire service, or the like. A vigorous system of flushing was resorted to in order to prevent this trouble, and at the same time some investigations were begun to ascertain its cause.

These investigations showed that the water from the deep wells before and after filtration was perfectly clear. A large amount of iron oxide accumulated on the filter. There was practically no deposit in the concrete pure-water reservoir after one year's use, but in the pipes which conveyed the water from the pure water reservoir to the pump well, and in the force mains from the pumping station to the distribution system, where the velocity of the water was only 0.85 ft. per second, there were found numerous brown flocks on the upper surface of the pipe. On the bottom there were deposits about 0.04 in. in thickness. The service pipes, which, with a few exceptions, were of 1-inch galvanized iron pipe, contained very little deposit, although, in a few cases, the inside diameter was reduced considerably by incrustation. But the galvanized iron strainers of the water meters were found to have their holes almost completely choked with a yellowish-brown mass, though the strainers made of copper or brass were but little stopped up.

In 1903 samples were sent to the London chemist, Mr. Bertram Blount. He found that the suspended matter contained 71.02 per cent. of manganese dioxide (MnO_2), and 5.95 per cent. of manganese oxide (MnO), although the Hungarian Chemical Institute failed to find a trace of manganese in samples taken under the same conditions. The investigations showed that the trouble was not due to iron, which was present in the water only to the extent of 0.025 part per million, but rather to the compounds of manganese which had been reported as existing only in traces. This manganese did not separate out in the quiet water of the reservoir, but the deposits were greatest on the vertical rough sides of the pipes, and on the screens of the meters in similar places.

The trouble was found to occur intermittently and was found to be greatest after periods of heavy rain. The reason for this was made clear by a study of the local geological conditions. The underground water at Arad flows from east to west, coming from the direction of the Carpathian Mountains 15 to 20 miles distant. Between the upper diluvial stratum and the lower stratum from which the well water is derived, there is a clay bed about 45 ft. thick which separates the two. The dip of the strata is such that the lower water-bearing stratum outcrops at the Carpathian Mountains, and it is known that at this point manganese is very abundant. In fact, manganese compounds often lie upon the surface of the ground exposed to the rains. The dissolved compounds thus find their way into the ground and to the wells at Arad.

From the location of the manganese deposits in the pipe, it was thought that the trouble could probably be avoided by installing a pressure filter at the end of the force mains, but it did not seem practical to do this. The most feasible plan seemed to be to place a filter at the lower end of the force main just outside the pumping station, and this was accordingly done. The results fully justified the expectations, and during the last 32 months the water in the city has been clear, while the street mains have not had to be cleaned, examinations showing that they were in no way incrusted. The pressure filters were furnished by Bell Bros., of Manchester, England, and this particular system is said to have been used because of its low cost and its simple operation. The filters are cleaned once in 10 to 25 days, and it is said that from 13,000 to 21,000 gal. of water are used each time for washing.

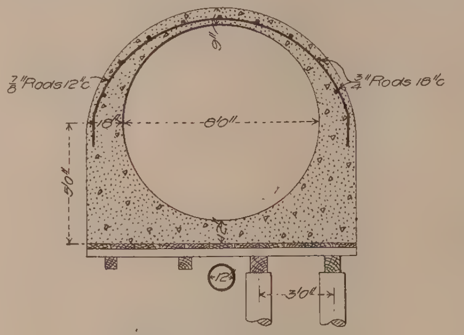
Experiments which were made on a small scale showed that by the addition of milk of lime to the well water, which has a hardness of 140 parts per million, a more complete separation of the manganese compounds could be obtained, but thus far it has not been necessary to resort to the use of chemicals. Had they known originally that this water contained manganese, it is probable that the design of the works would have been quite different with respect to the filtration of the water.

An Enormous Tunnel on the proposed canal between the Rhone River and Marseilles is reported in European papers to have been approved by the Bureau of Bridges and Highways of the French government. The tunnel is to be 4⅜ miles long, 72 ft. wide and 46.6 ft. high, and is estimated to cost $6,900,000.

The Ingleside Sewer, Borough of Queens, New York City.

A large, circular, reinforced concrete trunk sewer is now being built in the Borough of Queens, New York City, which will serve ultimately about 1,200 acres in the Ingleside district of that borough. Ingleside is a suburb of Flushing, and, while it is now only partially settled over most of its area, these conditions will soon be changed by the influx of population which will follow the improved transportation facilities soon to be afforded by the East River tunnels and new bridges. The surface of this district is flat or gently rolling, and the general elevation above mean high water varies between 10 and 110 ft.

The Ingleside sewer, which is to carry combined storm-water and house-sewage flow, has its outlet on Flushing Creek, a small creek which empties into Flushing Bay, on Long Island Sound. To comply with a State law, which prohibits the discharge of crude sewage into Flushing Bay, a cut-off has been provided near the outlet, where the dry-weather flow will be diverted through a 24-in. pipe and led to a disposal plant: this cut-off will be referred to later. The storm-water flow will be discharged directly into the creek, the dilution when the cut-off becomes inoperative being sufficient to make this admissible.

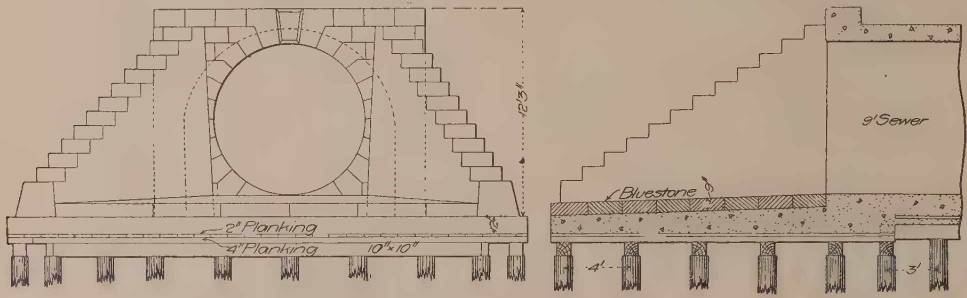


Section of 8-Foot Sewer.

The work now under contract involves the construction of 725 ft. of 9-ft. sewer, 1,580 ft. of 8 ft. 9 in., 1,007 ft. of 8 ft., 774 ft. of 6 ft. 6 in., 810 ft. of 6 ft., 1,830 ft. of 5 ft. 3 in. and 245 ft. of 2 ft. 6 in. A special outlet portal will also be built.

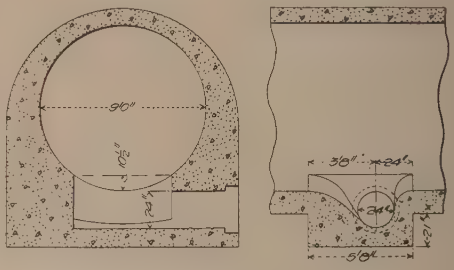
The sections for all sizes of the sewer, down to and including the 5 ft. 3 in. size, are alike in form, the outer sides of the invert below the springing lines being carried down vertically to meet the plane of the base. Ransome bars are used throughout as reinforcement, the transverse bars in all the larger sizes being bent to a three-centered curve, as shown in an accompanying cross-section of the 8-ft. sewer. Pile foundations are specified, to be used where necessary, but so far no piles or planking have been required. A sub-drain of 12-in. farm tile, laid as the work progresses, drains the trench without difficulty.

The outlet portal is designed to distribute the flow of storm water and prevent erosion near the mouth of the sewer. This portal consists of a 12-in. slab of concrete extending about 17 ft. in front of the mouth of the sewer, to form an apron, with a flaring wing wall at each side, as shown in accompanying sketches. The concrete apron is paved with 9-in. bluestone slabs, and the inside faces of the wing walls have a 2-in. facing of special mortar made of one part of cement, one part of sand and 1½ parts of granite dust. This facing mortar is placed at the same time as the body of the concrete. To divert the storm water into the channel of the creek the downstream wing wall forms an angle with the axis of the sewer 10 deg. greater than that formed by the upstream wall. The angles formed by the wing walls with the axis of the sewer are 30 deg. and 20 deg., respectively. Piles and planking, arranged as shown in the sketches, support the portal.



Elevation and Section of Ingleside Sewer Portal.

The dry-weather flow cut-off will be placed just above the outlet portal and will consist of a transverse depression in the main sewer, into which the sewage will drop and from which it will be carried away by a 24-in. pipe leading to the sewage disposal plant, to be constructed later on a site already secured near the outlet. The details of this cut-off are shown by accompanying sketches. With a cut-off of this type the flow to the disposal plant would continue uninterruptedly, even though the quantity of storm water entering the sewer diluted the sewage so greatly as to make the direct discharge of the mixture into the bay permissible. To avoid operating the disposal plant unnecessarily and to save the expense of constant attendance, which would be necessary with a manually-operated cut-off, an automatic cut-off will be placed on the 24-in. pipe outside the main sewer, so that as the storm-water flow increases the flow to the disposal plant will be gradually and automatically reduced and finally stopped entirely.



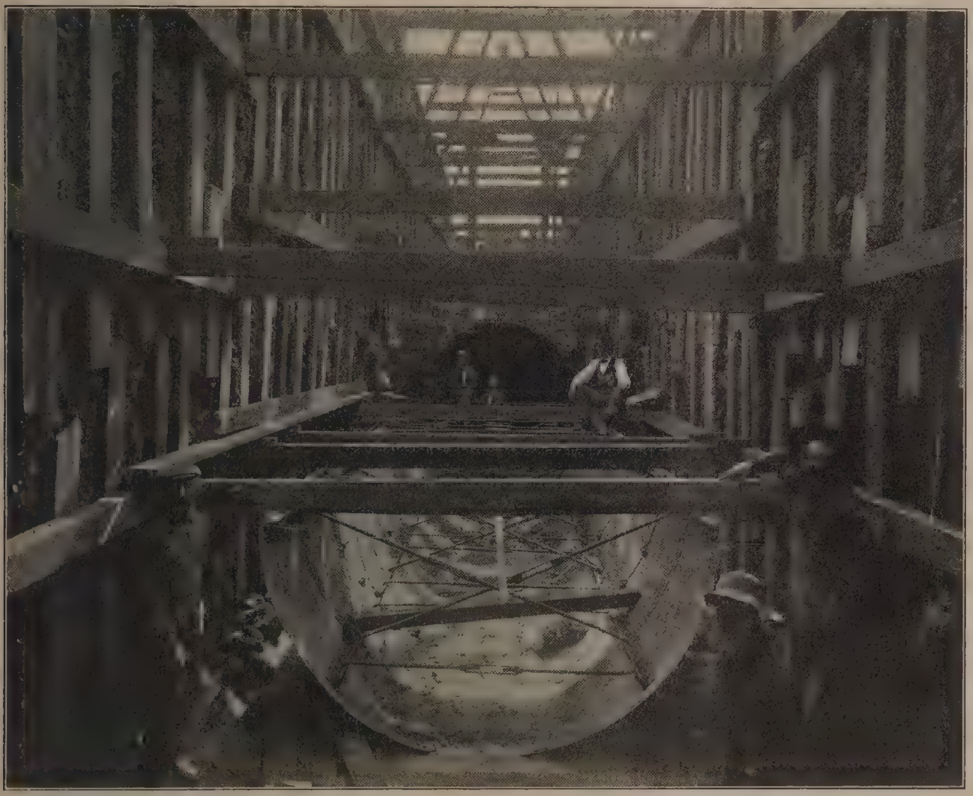
Dry-Weather Cut-Off.

At this time the 9-ft. sewer, except a short length near the outlet, has been completed, and work is in progress on the 8-ft. 9-in. section. The trench is excavated with pick and shovel, and the spoil is hoisted and delivered in 1-yd. Hayward buckets as back-fill over the completed part of the sewer by a Carson conveyor, operated by a Lidgerwood engine and boiler. This conveyor, which is one of the standard type manufactured by the Carson Trench Machine Co., consists of a series of A-frames spanning the trench and supporting a hanging rail, on which a hoisting carriage is drawn back and forth by cables. The A-frames are placed 16 ft. apart on centers, and each leg of each A-frame has a double-flanged wheel placed in a vertical plane parallel to the axis of the sewer. A line of light rails on each side of the trench forms a track, on which the whole conveyor, including the platform carrying the boiler and engine, runs. On the work in question the entire conveyor is about 300 ft. long. The soil in which the trench has been excavated thus far is gravelly and very firm, so that close sheeting has not been required.

The concrete, which is a 1:2:4 mixture of Alsen Portland cement and Cow Bay sand and gravel, is mixed by hand on a platform beside the trench and delivered to place through sheet-iron pipes. Hand mixing was adopted on the first part of the work because certain conditions prevented the economical use of a mixer. A Smith machine is on the ground, however, and will be used for the greater part of the work. For forming the crown and invert, sheet-steel centers of the standard type supplied by the Blaw Collapsible Steel Centering Co., are used. These are handled in 30-ft. sections, made up of 5-ft. lengths braced with rods equipped with turnbuckles in the usual manner. A mixture of kerosene and slush grease is used to lubricate the surface of the centers. Special care is taken to insure the construction of the invert at the proper grade, and to this end steel pegs are driven into the foundation slab, at 25 ft. intervals, while the concrete is still green, the tops of the pegs being exactly at grade. In addition to these there are the usual grade stakes outside the trench. The center line of the sewer is given by a double row of stakes, one on each side of the trench, the stakes in each line being at 25-ft. intervals and 25 ft. from the center line of the sewer.

The curved transverse rods are bent by a blacksmith, assisted by two laborers. Each rod is first run through a three-roll tire-bending machine, such as is commonly used in wagon shops. After the rods have been roughly bent in this manner they are tested on a wooden template and brought to exactly the right shape by blows with a sledge. In general, 60 or 70 rods can be bent in an 8-hr. day, and the results secured by this method have proved very satisfactory. In placing the rods in the trench they are hung from a ridgepole over the center of the invert and wired securely in place in the usual manner.

The work of the Bureau of Sewers in the Borough of Queens is under the general direction of Joseph H. De Bragga, superintendent of sewers, and Mr. J. H. Johnson, chief engineer. The plans and specification for the work described were prepared by Mr. Alberto F. Schreiner, assistant engineer. Mr. William L. Pyne, assistant engineer, is in charge of construction. Messrs. P. J. Murray & Bro., Brooklyn, are the contractors, Mr. A. B. Nichols, superintendent.



Invert Forms in Place, Ingleside Sewer.

Construction Methods in the Second Bergen Hill Tunnel of the Lackawanna R. R.

The second Bergen Hill Tunnel of the Delaware, Lackawanna & Western R. R. lies parallel to and with its center line 51½ ft. south of the center line of the present tunnel, which carries all of the traffic of the railroad from the West to Hoboken, N. J. The work on the new tunnel has been in progress since March of last year, and the rock excavation is approximately 40 per cent. completed at the present time. A general description of the traffic conditions at Hoboken and of the designs of the new tunnel were published in The Engineering Record of January 12, 1907.

Bergen Hill runs in general parallel to the Hudson River, and the tunnels, which lie in a general east and west direction, have their east portals about a mile west of the river front. The completed section of the new tunnel will be 30 ft. wide and 23 ft. 5 in. above the base of rail to the crown of the semi-circular roof arch. It is being driven through a very hard trap rock. The new tunnel will be lined throughout its entire length with concrete.

For construction purposes, as well as good ventilation after the tunnel is in operation, the work has been divided into sections by open cuts and air shafts. The two open cuts and the three shafts bear separate series of numbers, the shaft and the cut nearest the east portal being each called No. 1. In the construction work the cuts play the more important part, because from them headings are being driven in both directions, allowing the work to be carried on with full force at six different points. The shafts, on the other hand, though used to some extent for hoisting excavated material, are of more value in assisting ventilation, both during construction and future operation, by enabling the smoke from the blasts and the locomotives to be drawn off quickly.

Each of the open cuts is 80 ft. wide and 100 ft. long, and the shafts are 30 ft. wide and 10 ft. long. The open cuts are wide enough to take in both the old and the new tunnels, so that the four tracks are exposed, and cars can be switched from the one to the other to facilitate the removal of rock from the new tunnel during construction. The shafts, however, are wide enough to take in only the new tunnel, their axes being placed vertically over the center line of the latter.

The center of open cut No. 1 is about 1,650 ft. west of the east portal of the tunnel; center of open cut No. 2 is about 1,500 ft. beyond open cut No. 1, and the west portal is about 1,100 ft. from open cut No. 2. The three shafts are placed about midway of the divisions made in the tunnel length by the open cuts. The total length of the new tunnel is 4,280 ft., the same length as the present one.

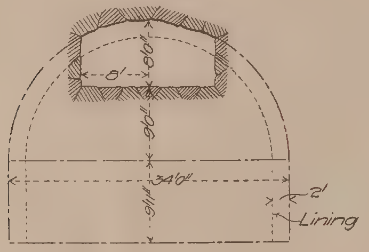
The contract for the original construction of the tunnel was let to the William Grace Co., and work was started in March, 1906, the drilling being done with electrically operated drills. Air drills were later substitued on the work, and on April 15, 1907, the contractor gave up the work, and since that time it has been carried on by the railroad company. The work of sinking the open cuts was started simultaneously with the opening of the approaches to the two portals, in March, 1906, and the shafts were sunk in time to meet the headings driven from the portals and the open cuts, though in the case of shaft No. 1 headings were driven from it for a short distance in each direction.

The work has been carried on by two different methods, illustrated in the accompanying drawings. One method consists in driving a top heading, having a width of 16 ft., symmetrically on each side of the center line of the tunnel, and a height of 8 ft., the roof approximating the outside line of the rock excavation. The other method is a combination of heading and bench excavation, in which the heading is driven 28 ft. wide and 8 ft. high, its end being at least 25 ft. in advance of the rest of the work. The headings are driven by placing the drill holes in the regular fashion, and the benches in the second method are blasted off by holes drilled vertically for the full depth of the bench. About 29 holes were required in driving the small top headings, the depth of the holes being from 7 to 8 ft. In blasting off the bench eight holes are placed in a line transverse to the axis of the tunnel.

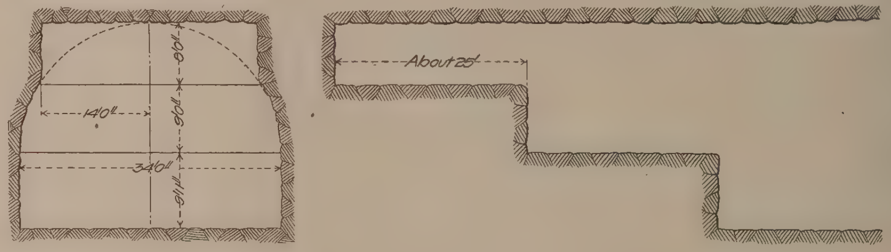
In driving the top heading each shift consists of 5 drill runners and 5 helpers, 10 muckers, 2 foremen, a water-boy and a hoisting engineer and a signal man for the derricks. For driving the full heading, where the steam shovel was used, 10 drill runners and 10 helpers were required; 16 muckers, 2 foremen, 2 men for carrying drills to and from the blacksmith's shop and a water-boy. In using the traveling derrick for mucking, the force was 2 foremen, 6 drill runners and 6 helpers, 13 muckers, 2 drill carriers and a water-boy. In addition to this force, where rock had to be hoisted up through the open cuts, a hoisting engineer, a signal man and a dump man were required for operating the derrick and teams for disposing of the spoil on the surface. In the east portal headings an engineer and brakeman were required for handling the narrow gauge locomotive and a crew for the steam shovel. Work is being carried on night and day in two 10-hr. shifts. Almost all of the drills are sharpened in an Ajax Junior drill sharpener, though some are sharpened by hand.

The work in the heading extending from the east portal has been carried on entirely by the heading and bench method, opening the full section at once. A standard gauge track is laid along the north wall of the tunnel for the use of a Marion steam shovel. Alongside of this track are two narrow gauge tracks, on which are operated 3-yd. dump cars, hauled by a dinky locomotive. The track farthest from the steam shovel, used for pushing in the empty cars, is extended up close to the face of the work and a switch cut in to the other narrow gauge track a short distance back toward the portal. The empty cars are pushed forward by hand beyond the switch to the face of the work and after being loaded are hauled out by the dinky locomotive which runs over the narrow gauge track next to the steam shovel. The cars are hauled out through the east portal to a trestle where they dump into standard gauge Hart convertible dump cars in which the spoil is hauled to Hog Mountain, on the other side of Bergen Hill, to be crushed for ballast. At the present time the full section of the tunnel has been excavated between the east portal and shaft No. 1. As stated above, a short distance of top heading was driven in each direction from this shaft, but now that the full section is completed east of the shaft the heading and bench method will be used. continuing with the steam shovel and the narrow gauge track utilized in the section already completed.

The tunnel driving from open cut No. 1 has been entirely by the top heading method, the work westward from the cut being started in March and eastward in June of this year. Up to October 1st, 462 ft. of the small heading had been driven eastward and 876 ft. westward. The bottom of the cut has been carried down to the sub-grade level on the south side for the new tunnel, but on the north side the rock has merely been removed from the top of the old tunnel, the arch as yet being undisturbed. As soon as the arch of the old tunnel is removed a cross-over can be built from the tracks in the old tunnel into the new one and the spoil hauled away in standard gauge dump cars as is now being done in open cut No. 2. All of the spoil from open cut No. 1, from the excavation of the cut itself and the driving of the headings in both directions, has been hoisted to the surface in scale pans by a derrick placed on the side of the cut and dumped into wagons which hauled it about 650 ft. to a crushing plant, which supplies all of the stone for the concrete lining of the cuts and the tunnel.



Top Heading Method.



Combination Heading and Bench Method.

Shaft No. 2 was sunk in time to meet the top heading coming west from open cut No. 1, and the muck was hoisted up through it instead of being hauled back and hoisted through the open cut. The derrick is so placed that it can swing the scale pans from the shaft and dump them directly to the storage pile alongside the crushing outfit. The top heading, which was started by driving west from open cut No. 1, had, on Oct. 1 advanced 325 ft. beyond shaft No. 2.

The tunneling operations from open cut No. 2 were started in March of this year by driving top headings in both directions and after the one to the east had advanced 80 ft., and the one to the west 100 ft., the use of the full section method was adopted. On October 1st, 1907, the latter had been pushed 245 ft. westward from the cut and 200 ft. eastward. This cut has been carried down to the sub-grade level of the new tunnel and the arch of the old tunnel has been removed and a cross-over installed on which standard gauge dump cars are run into the new tunnel for hauling away the spoil. Previous to the removal of the arch of the old tunnel, however, all of the material excavated in sinking the cut and driving the headings was hoisted in scale pans to the surface and hauled away in wagons. The cross-over runs from the old tunnel into the west headings of the new tunnel. At the present time two standard gauge tracks are laid in the heading west from the cut and one of these tracks, the one against the south wall of the new tunnel, is continued backward, beyond the cross-over to the old tunnel, into the east heading. A small derrick mounted on a flat car works on the northernmost of the two standard gauge tracks in the west heading and hoists the scale pans into which the muckers load the shattered rock, and dumps them directly into standard gauge Hart convertible dump cars on the other track. These dump cars are handled directly by a locomotive, switched over into the present tunnel and hauled to Hog Mountain, where the rock is crushed for ballast. The heading has not been pushed far enough westward to allow tail-room for switching cars backward beyond the cross-over into the east heading. For this reason the muck in the east heading is loaded by hand into scale pans running on low push cars. These cars are brought out into the open cut and a derrick at the surface lifts them from the push cars and dumps them into one of standard gauge cars standing on the cross-over.

Shaft No. 3 was sunk for purposes of ventilation, the only rock that was hoisted out of it being removed in sinking the shaft.

The operations from the west portal had been carried on since the beginning in full section by the heading and bench method, using a derrick car similar to that which is now working west from open cut No. 2. The excavation from the west portal has been discontinued for a period of about four weeks in order to get in a section of tunnel lining near the portal where some bad roof was encountered, the tunnel driving meanwhile being prosecuted by the top heading method and the muck thrown back into the portion of the tunnel where the full section has been excavated. Three hundred and fifty-six feet of the full section have been driven and the top heading on October 1st extended 276 ft. further. The two headings, that eastward from the west portal and the one west from open cut No. 2 will meet this month. On the completion of the section of lining a steam shovel will be run into the heading from the west portal and the work carried on in the same manner as described for the east portal.

Up to October 1st of this year, 1,748 ft. of top heading and 1,499 ft. of the full section had been driven, this being approximately 41 per cent. of the excavation. At the present rate the full section should be blasted out by September of next year. The work has been considerably held back by the restriction of blasting periods. No blasting is done at night and during the day it has been confined to four periods by the train schedule, so as not to interfere with the traffic through the old tunnel. The blasting is done at three periods in the morning, at 7, 9:45 and 10:50, and in the afternoon at 2:30. Immediately after the shots have been fired, an inspection car is run through the old tunnel and with the aid of acetylene lights the brick arch and side walls are carefully inspected. During the entire time that the work has been in progress no damage has been done to the old tunnel. The arch of the old tunnel consists of seven rings of brick laid in cement mortar and such is its strength that in removing it at the open cuts it has been necessary to use heavy wedges to dislodge the brick.

About 31,000 cu. yd. of concrete will be required for the tunnel lining.

In order to assist in the removal of the brick arch from the old tunnel, lagging was placed on the intrados of the arch. It consisted of 4-in. timbers held in place by old rails bent to the curve of the arch, the rails being carried by sills and posts against the tunnel walls.

Ingersoll-Sergeant drills are used entirely on the work. In the blacksmith shop the cylinder of an air drill has been mounted on a standard and is used as a steam hammer for welding broken shanks of drills. A 125-h.-p. Ames engine and a 25-h.-p. Atlas engine are used for driving direct current generators which supply current for lighting the tunnel and for the motors of two electrically operated derricks. The crusher already referred to is a Scholl Climax jaw crusher. The compressor plant is situated a short distance west of the west portal of the tunnel, and contains four compressors, three of the Ingersoll-Sergeant Class A piston inlet type with a capacity of 1,200 cu. ft. of free air per minute each and one McKiernan Drill Co. compressor with a capacity of 1,200 cu. ft. Steam is generated by nine locomotive boilers, with a combined capacity of 800 h.-p.

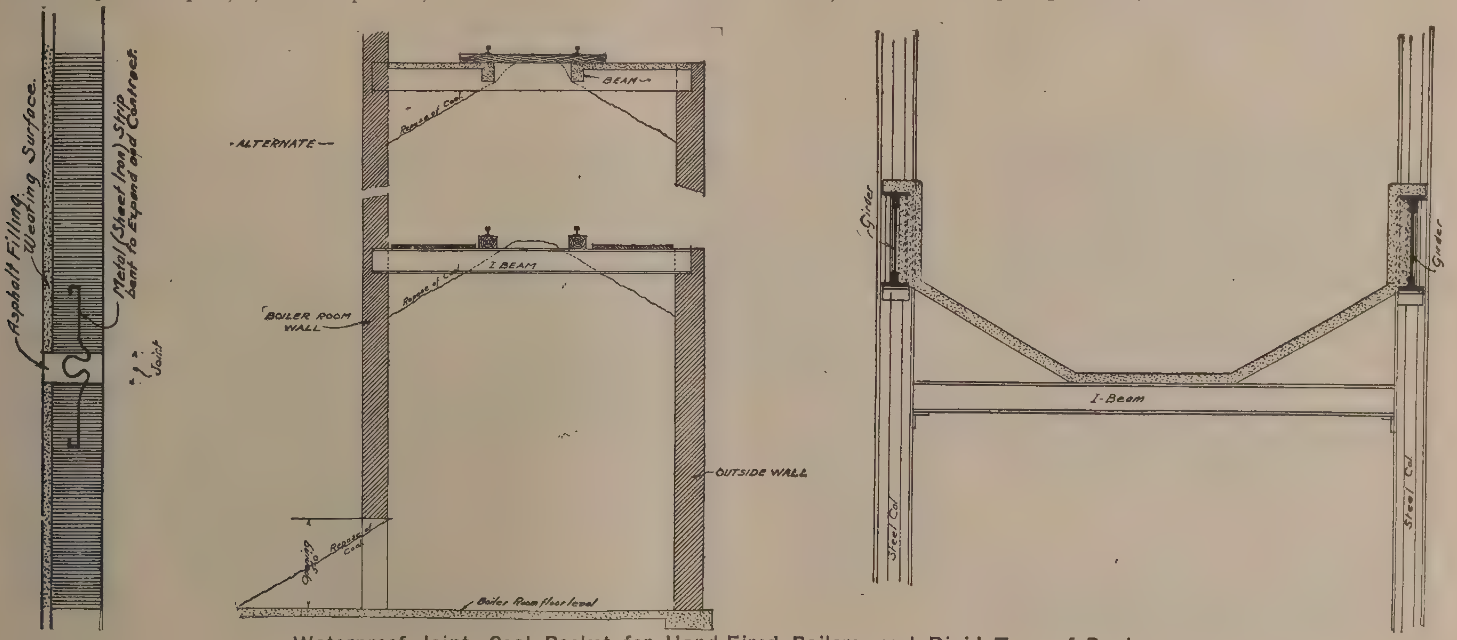
The work is being carried on by the forces of the Delaware, Lackawanna & Western R. R., under the direction of Mr. L. Bush, chief engineer. Mr. F. L. Wheaton is in direct charge, assisted by Mr. O. H. Kellogg.

Coal Production in the United States is classified by the Geological Survey in some recent statistics which show that in addition to the anthracite produced in Pennsylvania, 50,400 tons were mined in Colorado in 1905, and 60,300 tons in 1906. New Mexico produced 24,400 tons in 1905, but none in 1906. This is all the anthracite production in the country, but semi-anthracite was reported from Pennsylvania, Colorado, Indian Territory, Virginia, Montana and Arkansas. Bituminous coal was produced in 27 states and territories in 1905 and in 24 in 1906. Semi-bituminous coal was mined in 17 states and territories, West Virginia leading. Wyoming is in the lead in the production of lignite, over 70 per cent. of the coal from that state being so classed. The so-called black lignites of the Rocky Mountain states are distinct from real lignite or brown coal and are termed sub-bituminous coal by the Geological Survey. Wyoming leads in producing this variety, Colorado is second and New Mexico third. The principal producers of true lignite or brown coal are Texas and North Dakota. The comparatively small amount of cannel coal was from Kentucky, Indiana and West Virginia.

Coal and Ash Bins.

The cost of handling coal and ashes is often an expensive item in the operating expenses of a power station, and it has been found that even in the smaller plants the design of coal and ash bins may have an appreciable influence on maintenance charges. This subject was discussed at some length by Messrs. H. T. Campion and Wm. McClellan in a paper on the "Influence of the Design of Railway Structures on Economy of Operation," read at the recent convention of the American Street and Interurban Railway Association, from which the following notes are taken:

In the suspended, or catenary type, the structure requires frequent painting and, to insure a reasonable long life, a lining is demanded. This lining is usually built of concrete in which a metal mesh should be placed to prevent, as much possible, the cracks which arise, not only from temperature variations, but also from alterations in the shape of the structure due to load changes. If long life and low maintenance is to result, the effect of this alteration in shape due to change of load must be carefully looked after in design. Water draining over coal forms an attacking sulphurous acid. Should cracks and fissures develop in the concrete lining, this acid will enter, not only corroding the steel structure but also eating its way into the more porous concrete and possibly neutralizing its alkaline properties.



Waterproof Joint, Coal Pocket for Hand-Fired Boilers, and Rigid Type of Bunker.

In the rigid type of bunker, we have other conditions to guard. The typical sketch of this type which is shown has steel for the main supporting members because the loads, or their resulting movements are so great as to make the entire use of concrete inadvisable on account of the great bulk necessary and the expense entailed by its added dead load on the foundations of the structure. The principal danger to be guarded against is its tendency to crack from temperature changes, opening it to the dangers enumerated in the case of concrete linings of steel bunkers, and, furthermore, causing unsightly leaks in the boiler room. There is also the abrasive action of the falling coals on the surface of the concrete.

The last item can be guarded against by applying to the inner surfaces of the structure a hard, well-rubbed granolithic surface which, if properly applied, will resist such abrasion as a comparatively soft material as coal will cause.

The first objection, temperature cracks, can and should be taken care of in the design. The units of the structure should be in short lengths and a water-tight joint can be provided in a number of ways. An accompanying illustration shows one simple and effective way of making a joint.

It is difficult to give any accurate comparison of costs of the two types of bunkers. There is, of necessity, great variation owing to difference of size, design, and amount and kind of coal passing through. The life of the unlined bunker with average coal will be perhaps eight to ten years. Messrs. Campion and McClellan took down one and found, by drilling, the metal shell reduced more than one-half in thickness in this time. Maintenance on the rigid concrete type and on the lined catenary type is practically zero, though the rigid type has somewhat the advantge. Depreciation on the rigid type and concrete lined type is practically zero.

What is more surprising, however, is the great lack of attention given to economical handling of coal for hand-fired boilers. Frequently an overhead bunker is advisable. If not, the scheme shown in one of the accompanying cuts is very useful and inexpensive. A series of bins is built using the boiler room wall for one side. The illustration is self-explanatory.

In the handling of ashes, there often could be much improvement.

Where the ashes drop directly underneath the boilers, pockets can be most effectively and economically constructed of concrete and made a part of the boiler room floor structure, leaving a comparatively clear basement for the handling of ashes, either by the industrial railway method or by some conveying scheme.

In some cases, pockets of this description have been lined with fire brick but the temperatures are so much under the point where concrete loses its water of crystallization that it seems an unnecessary expense to spend money for this purpose.

In storing ashes removed from the boilers for final disposal at such times as best suit the operating conditions of a railway, reinforced concrete ash bins have been almost universally adopted on account of the fact that metal structures are not only costly but have a very short life under the trying duty of containing coal ash with its high percentage of corrosion acids.

These concrete structures too can be arranged in so many ways to suit local conditions, that they meet requirements that no other material could. Their cost varies considerably on account of location, height, and ratio of wall, floor, and roof area to cubical contents, but a range of from 30 to 50 cents per cubic foot of contained space will cover most cases. In large structures, the price may be even lower, but as no maintenance of the structure is required, the first cost is the last cost.

Mechanical Spreader for Roadway Screenings.

A contract for bitulithic pavements covering about one mile of street is now being executed in Providence, R. I., by Warren Bros. The streets have an electric car track in the center and the deep girder rails are seated on continuous concrete longitudinal stringers. On each side of each rail there are two rows of granite blocks. Narrow strips of concrete are placed outside each outer row to retain the hot tar or grout which is poured between the blocks, and the remainder of the surface is covered with the usual bitulithic finish. The fine screenings are liberally applied and the residue swept off.

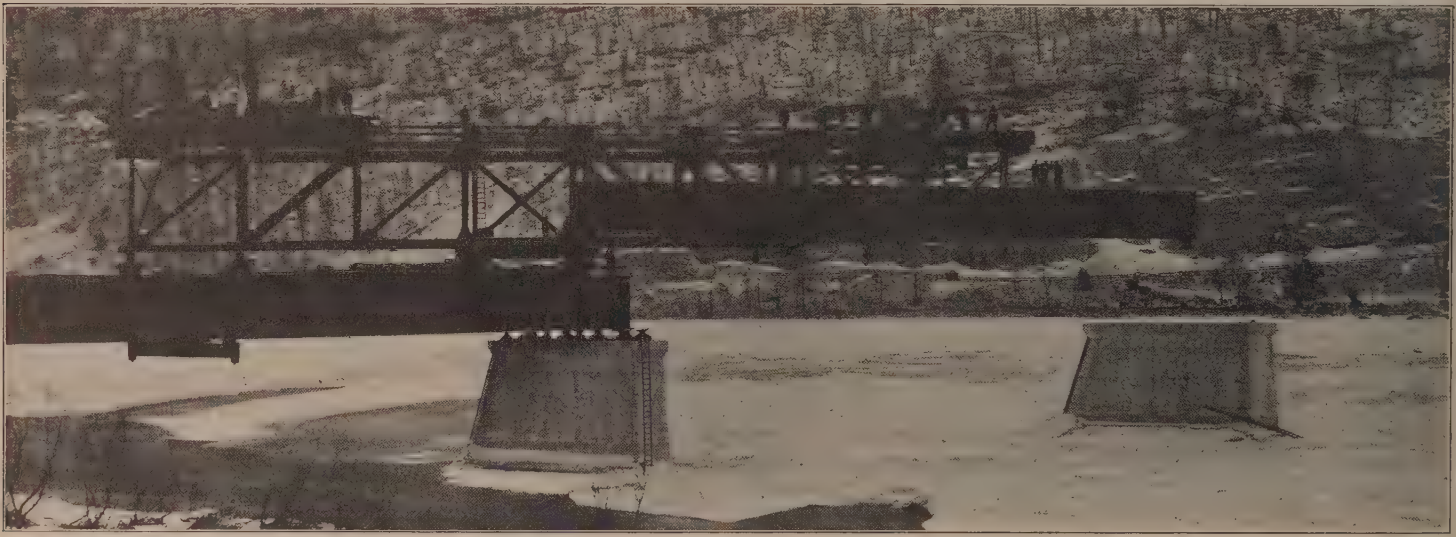
A quick and uniform distribution of the screenings is secured by a ¼-yd. steel rectangular hopper mounted on two wheels and pushed by hand over the surface of the pavement. A circular opening about 4 in. in diameter in the bottom of the hopper is closed by a sheet steel cone about 2 ft. in diameter with a vertical axis projecting above the top of the hopper where it is miter-geared to a small horizontal transverse shaft operated at the opposite end by a sprocket chain engaging the axle of the wheels on which the hopper moves.

The cone has a vertical adjustment controlled by a lever engaging a row of notches in a guide bar attached to one side of the hopper. By this means it can be raised or lowered to regulate the amount of screenings delivered from the hopper through the annular opening between it and the cone and distributed around the circumference of the cone. Short radial ribs project above the surface of the cone on the lower edge between which the screenings are discharged uniformly in all directions as the hopper is pushed rapidly over the pavements, causing the cone to revolve.

STEEL STRUTS AND BEAMS for lining tunnels have been used for 12 to 15 years by the Susquehanna Coal Co., in Pennsylvania. The consulting engineer of that company, Mr. R. V. Norris, designed a form of gangway support consisting of posts of channels with an I-beam cap. The members are put together with pins and wedges, and the posts rest on cast-iron bases, which enable the whole construction to be taken down or to be adjusted very quickly. Some of these frames have been exposed to constant contact with mine water but they show little sign of corrosion, although the only protection given them has been a good heavy coat of paint from time to time.

A Long Plate Girder Bridge.

The main line of the Lehigh Valley R. R. crosses the Susquehanna River at Towanda, Pa., on a double-track skew bridge with 14 deck plate girder spans about 26 ft. clear of the water and about 5 ft. clear of high water. The sub-structure consists of two abutments and 13 piers, all of concrete founded on rock and most of them skewed about 50 deg. with the bridge axis. In the superstructure there are 56 nearly duplicate plate girders from 110 ft. to 129½ ft. long over all with their transverse and lateral bracing.



Girder of the Lehigh Valley R. R. Bridge at Towanda, Pa., Suspended from Traveler Overhang.

At each end of the bridge several spans form chords of a 3½ deg. curve and in the middle of the bridge they are on a tangent symmetrical with the bridge axis and carry the tracks at a level grade about 38½ ft. above low water level. They are made of soft steel designed according to the railroad company's specifications for a maximum load on each track of two locomotives each with 200,000 lb. driver load on a 15-ft. wheel base followed by a train load of 5,000 lb. per lin. ft. For the longest span the dead load is assumed at 2,600 lb. per lin. ft., and for the shortest at 2,400 lb. The maximum flange stress is 290,000 lb. and the maximum end shear is 308,600 lb.

On the curved section the maximum top lateral diagonal stress is 44,000 lb. wind stress and 16,000 lb. centrifugal force, resisted by two 6 x 4 x 9/16-in. angles at a 10.6 sq. in. area and secured at the end by sixteen ⅞-in. field driven rivets. In the tangent spans the centrifugal force disappears and the 44,000 wind stress is provided for by two 4 x 3 x 9/16-in. angles with a cross-section of 5.76 sq. in. The minimum diagonal stress is 1,800 lb., resisted by a single 4 x 3 x 7/16-in. angle. The vertical transverse frames at the skew end are made with pairs of 5 x 3½ x ½-in. angles and with pairs of 4 x 3 x 7/16-in. angles at the intermediate skew points. At intermediate tangent points they are made with single 5 x 3½ x ½-in. angles.

The long girders have a 120 x 9/16-in. web in lengths of 18 to 24 ft. spliced with four vertical rows of shop driven rivets through pairs of 13 x ⅜-in cover splice plates 7 ft. 4 in. long. The webs are assembled to provide a cambre of ¾ in. at the center point. In each flange there are two 8 x 8 x ¾-in. angles spliced about 99 ft .from one end with an 8 x 8 x ½-in. cover angle 3 ft. long. The splices are staggered on opposite sides of the webs and in the top and bottom flanges. The flange has also a pair of 16 x ⅝-in. side plates made in two pieces each and spliced at the same point as a flange angle.

The top flange has one full-length 23 x 9/16-in. cover plate, 84 ft. 3 in. long; one 67 ft. 9 in. long and one 23 x ¼-in. cover plate 49 ft. 9 in. long. The bottom flange has four 23 x 9/16-in. cover plates, the longest of them being 95 ft. 9 in. long. Pairs of 6 x 4 x ½-in. angles and fillers divide the webs into panels of 6 ft. except at the ends where they are slightly irregular and over the bearing are reduced to 2 ft. 9½ in. reinforced with four pairs of angles.

A 20 x ¾-in. sole plate 3 ft. long is countersunk riveted to the bottom flanges at each end, and to it there is secured by eight 1¼-in. bolts a cast-steel shoe with a continuous half-hole bearing for a 4½-in. pin 25 in. long between centers. At the expansion end a pedestal similar to the shoe inverted engages the same pin with a clearance of ¼ in. between it and the shoe and is seated on a nest of seven segmental rollers 6¼ in. in diameter, slotted at the center to engage 2¼ in. guide ribs projecting from the bottom of the pedestal and from the top of the bed plate. The 36 x 37½-in. bed plate is planed on the upper face to a thickness of 1 in., and has riveted to the longitudinal edges Z-bars about 7¾ in. high which protect the ends of the roller nest and engage the upper surfaces of the base plate of the pedestal, thus excluding snow and rubbish to a large degree from the bearings. The bed plates are seated on sheets of lead ¼ in. thick and similar sheets are provided under the fixed end pedestals, which differ from those at the expansion ends in that they are made enough higher to compensate for the absence of the rollers and bed plates and allow the masonry seat to be finished at the same height at both ends. The 129 ½-ft. girders are 126½ ft. long on centers of bearings and weigh 113,000 lbs. each. The total steel weight of the bridge is 7,500,000 lbs.

The bridge was erected by an overhead cantilever traveler running on the completed spans and projecting far enough in advance to set the girders of the succeeding spans in position on the substructure. The traveler virtually consisted of a 147-ft. lattice girder span, with trusses 23 ft. apart and 18 ft. deep on centers and connected by overhead bracing in the planes of the top chord thus allowing clearance for the girders to pass between them from end to end over a single lower chord transverse strut about the middle of the span. The lattice girders were divided by vertical members into 21-ft. panels, each of them braced with a single diagonal, and one truss was set one panel in advance of the other to correspond with the skew of the substructure. The lattice girders had rectangular top and bottom chords, each made with a pair of 15-in. channels back-to-back, having web connection plates shop riveted to them and projecting beyond their inner flanges to receive the vertical and diagonal members field bolted to them.

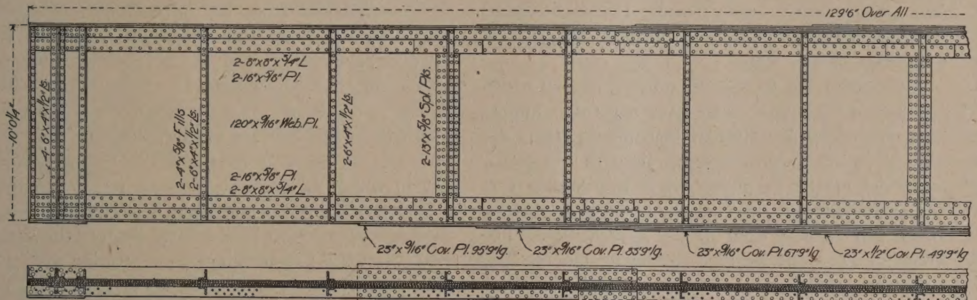
The transverse beams connecting the upper ends of the vertical post support longitudinal beams which provide tracks for carriages with hoisting tackles operated by two engines on a top chord working platform at the rear of the traveler. The traveler was nearly balanced on wheels at four lower chord panel points near the center of the girder and was partly counterweighted by the hoisting engines and their boilers and supplies. When in service the traveler was moved out to the end of the last completed span with its forward end projecting beyond the center of the next span. The rear end lower chord panel points were blocked up from the finished span and were securely anchored to it by a yoke made with vertical screw rods and the horizontal transverse girder connected to them and taking bearing on the bottom flanges of the permanent girders. The girders for the next span were delivered on three cars each inside the rear end of the traveler and were unloaded and moved forward by the trolley hoist which lifted them clear of the cars, moved them forward and lowered them to their final position on their pedestals. By this method the use of falsework was eliminated and the girders were unloaded and erected at the same operation by a comparatively small force of men. The traveler was adapted to be easily assembled and taken apart and shipped back to the shops for future use, thus making it a permanent tool.

The bridge was built and erected by the Phœnix Bridge Co. Mr. John Sterling Deems, chief engineer, and Mr. A. B. Milliken, superintendent of erection.

THE ALUMINUM CELL or electrolytic lightning arrester is one of the most recent developments in the field of high-tension transmission lines. The property of this cell in allowing free flow of current in one direction and but slight flow in the opposite direction, until the applied voltage reaches a certain critical value, is used to permit static charges to be freely dissipated to the earth, while high resistance is offered the opposite flow. Each cell will withstand 250 to 280 volts alternating, and arresters for high voltages are constructed of a multiplicity of cells with a "horn" air gap of merely sufficient opening to assist in suppressing an arc. The arrester then serves as a safety valve to the system, taking no current at the operating potential, but discharging any abnormal high potential, so that the circuit potential is not materially disturbed.

Punishment for Waste of Well Water in California.

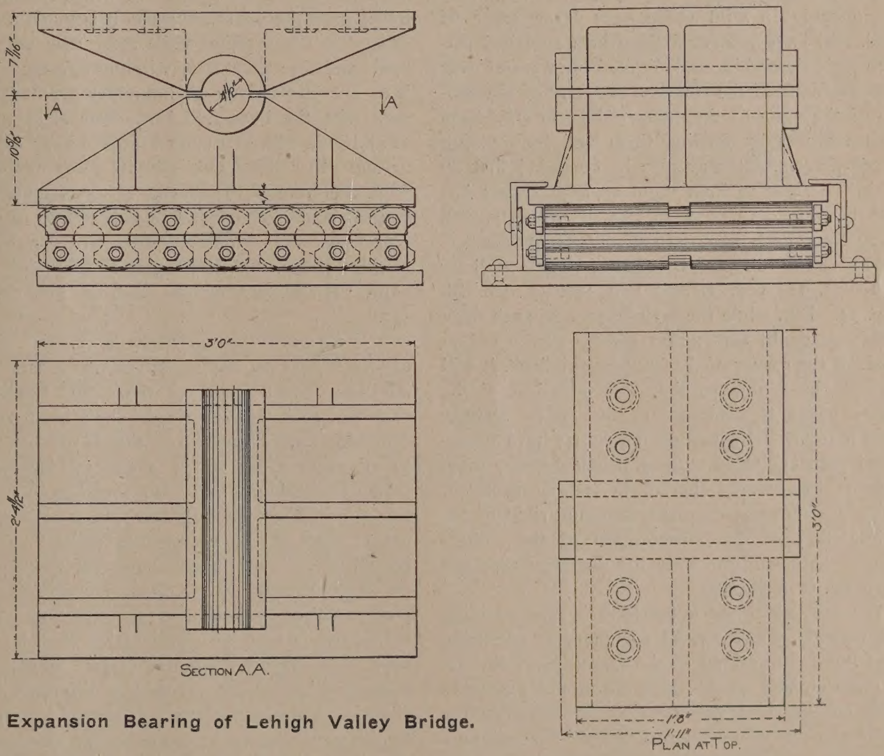
Early this year, the California legislature passed a bill to prevent the waste of water from the artesian wells that are such an important source of supply for domestic purposes and irrigation in some parts of the State. The law is a drastic one, and naturally enough has led to a suit by J. L. Elam to test its legality. This has been settled by the following unanimous opinion of the California Court of Appeal, delivered by Judge Allen:



Part Elevation of a Girder of the Lehigh Valley R. R. Bridge.

This is an application for a writ of habeas corpus presented by petitioner, who alleges that he is restrained of his liberty under a commitment issued upon default in payment of a fine assessed against him for a violation of the act of the Legislature approved March 6, 1907 (St. 1907, p. 122, c. 101), entitled "An act to prevent the waste and flow of water from artesian wells, and prescribing penalties therefor, and defining waste and artesian wells."

It is petitioner's contention that this statute is violative of the Constitution of the United States and of the Constitution of the State of California, and in conflict with the general laws. Section 1 of the act under consideration provides that an artesian well which is not capped or provided with mechanical appliances for arresting the flow of water therefrom is a nuisance, and the owner of the land upon which the same is situated is declared guilty of maintaining a nuisance if he suffers it to remain so uncapped or unprovided with mechanical appliances for arresting the flow, and any person maintaining such nuisance, or causing or permitting water to unnecessarily flow from such well, or to go to waste, is guilty of a misdemeanor. By Section 2 an artesian well is defined to be an artificial hole made in the ground through which water naturally flows from subterranean sources to the surface of the ground. By Section 3 waste is defined to be the causing, suffering or permitting the flow from an artesian well to run into any bay, pond or channel, unless used thereafter for the beneficial purposes of irrigation of land or domestic use, or into any street, road or highway, or upon public land, unless it be used for the irrigation thereof or for domestic use or the propagation of fish. It is further provided that, when water is run upon land for irrigation purposes, if more than 10 per cent. thereof be allowed to escape therefrom, the same shall constitute waste. Section 5 provides a penalty for the violation of any of the provisions of the act.



Section A.A.

Plan at Top.

Expansion Bearing of Lehigh Valley Bridge.

The first point made by petitioner—which is that the act is violative of the fourteenth amendment of the Constitution of the United States, which provides that no State shall "deprive any person of life, liberty or property without due process of law, nor deny to any person within its jurisdiction the equal protection of the law," and of article 1, section 1, of the Constitution of this State, which provides that "all men are by nature free and independent, and have certain inalienable rights, among which are those of enjoying and defending life and liberty, acquiring, possessing and protecting property," and of section 13, article 1, which provides that no person shall be "deprived of life, liberty or property without due process of law"—seems to have been met and demonstrated to be untenable by the Supreme Court of the United States in the case of Ohio Oil Co. v. Indiana, 177 U. S. 190, 20 Sup. Ct. 576, 44 L. Ed. 729.

By that case it is established that water, oil, gas and all fugitive substances held in their natural subterranean reservoirs are exceptions to the general rule establishing absolute ownership in the proprietor of the surface of all that lies underneath; that these minerals, being migratory in their nature, having no fixed situs, are a part of the soil only so long as they are on or in it, but after they escape and go to other lands the title of the former owner is gone; that it follows therefore that no one owner of the surface of the earth within the area beneath which these minerals move can exercise his right to extract from the common reservoir in which the supply is held without diminishing the source of supply as to which all other owners of the surface must exercise their rights; that, in consequence of the nature of the deposits, of their transmissibility, of their interdependence, of the right of all, and of the public at large, the State could lawfully exercise the power to regulate the right of the surface owners among themselves to seek to obtain possession, and to prevent the waste of the products in which all the surface owners within the area wherein they were deposited, as well as the public, had an interest. "No devesting of private property under such a condition can be conceived, because the public are the owners, and the enacting by the state of a law as to the public ownership is but the discharge of the governmental trust resting in the state as to property of that character." This water, the ownership of which until actual possession is acquired being in the public, or at least that portion of the public who may own the surface of the soil within the artesian belt, is subject to a reasonable use only by those interested therein.

This reasonable use is determined in Katz v. Walkinshaw, 141 Cal. 134, 70 Pac. 663, 74 Pac. 766, 64 L. R. A. 236, 99 Am. St. Rep. 35, to be the use of such amount of the subterranean water "as may be necessary for some useful purpose in connection with the land from which it is taken." The conditions existing in this state with reference to the necessity for the conservation of irrigating waters are most clearly set out in the case last cited, and the reasons for the rule restricting the use clearly shown. Whenever a landowner exceeds this reasonable use, he is appropriating to himself that which belongs to others who are entitled to a like use, and to that extent is obstructing the free use of property so as to interfere with its comfortable enjoyment, and which, by sections 3479 and 3480 of the Civil Code, is declared to be a public nuisance. Whatever right one has, even in his own, is subject to that established principle that his use shall not be injurious to the rights of others, or of the general public. This act therefore relates to waters, the right to the use of which is common to a large portion of the community, and affects the general public right. Legislation in relation thereto affects the public welfare, and the right to legislate in regard to its use and conservation is referable to the police power of the state, which is declared in Ex parte Whitwell, 98 Cal. 78, 32 Pac. 870, 19 L. R. A. 727, 35 Am. St. Rep. 152, to be "the power to make laws to secure the comfort, convenience, peace and health of the community." "The police power deriving its existence from the rule that the safety of the people is the supreme law, justifies legislation upon matters pertaining to the public welfare, the public health, or the public morals." Ex parte Drexel, 147 Cal. 766, 82 Pac. 429, 2 L. R. A. (N. S.) 588. It is settled law that all property is held subject to the exercise of police power, and that provisions of the Constitution declaring that property shall not be taken without due process of law have no application in such cases. Odd Fellows' Cem. Ass'n v. San Francisco, 140 Cal. 230, 73 Pac. 987.

It is further contended by petitioner that the act violates section 21, art. 1, of the state Constitution, which provides that "no special privileges or immunities shall ever be granted which may not be altered, revoked, or repealed by the Legislature, nor shall any citizen, or class of citizens, be granted privileges or immunities which, upon the same terms, shall not be granted to all citizens"; and he endeavors to demonstrate this proposition by the assumption that the surface owners are not prohibited by this act from extracting from this common source of supply any quantity thereof by means of pumps, that no attempt is made to restrict the use after the same is so pumped, and that the waste of such water so pumped is not violative of the act, and illustrates the claimed distinction by the statement that certain gun clubs within the arid region are pumping large quantities of this subterranean water, by means of which duck ponds are filled and maintained, while other gun clubs whose ponds are fed by artesian wells are restricted in the use of the flow therefrom.

It may be conceded that the courts have recognized the right of gun clubs to practically create a monopoly in wild game over large areas of land, and have protected them in a so-called private proprietorship and limited dominion over such portions of the common property of the people of the state as they may induce to stay upon such reserves by feeding them and maintaining ponds therein. It may also be conceded that an exclusive right to hunt upon such preserves has also been held to be a species of property, and injunctions have been issued to prevent interference with the full exercise of such rights. Kellogg v. Kings, 114 Cal. 378, 46 Pac. 166, 55 Am. St. Sep. 74. But, while the maintenance of such duck ponds no doubt contributes greatly to the enjoyment of the owner of the hunting privilege, it will scarcely be contended that this is a use of the water which is beneficial to the land. Neither does it follow that because the courts have recognized such exclusive hunting privileges they must support the owners thereof in an encroachment upon another more necessary common right of the public, that of the conservation of the subterranean waters of the state for domestic uses and purposes of irrigation.

We are not to be understood in thus meeting the reasons of petitioner's argument as admitting that there is anything in the language of the act in question that would affect a gun club any more than an individual association, or incorporation. That one may show matters dehors an ordinance which is referable to the police owner that such ordinance by reason of particular facts and circumstances is unreasonable anl oppressive as to him is determined in Re Smith, 143 Cal. 370, 77 Pac. 180. No reason suggests itself why such right may not be recognized when the state has sought to exercise the same power; and, while courts may to a degree supervise such power, "they will not interefere except where the case be plain that needless oppression is worked and constitutional rights invaded." In Re Smith, supra. Nothing appears upon the face of the act, or in the record on this application, from which it can be said there is any discrimination as to the class of persons who may violate the provisions of the law. No special immunities or privileges are granted to any club, clubs, persons, or persons. That some clubs may maintain their ponds by pumping, while others, more fortunate, have theirs maintained by artesian wells or running streams, or tide water from the ocean, in no way affects the question. As well might it be said that Legislative action affecting tide lands created special privileges or immunities because the duck ponds of the clubs relying upon tide water might be affected thereby.

As we have before attempted to show, no surface owner possesses the right to extract the subterranean water in excess of a reasonable and beneficial use upon the land from which it is extracted. Any additional extraction is not in the exercise of a right, if by such exercise the rights of others are injuriously affected. Nor can an appropriator take more water than he can beneficially use. Hence it follows that no discrimination is made between parties entitled to the exercise of a common right. Under the act in question, all may exercise their full legal right with reference to this water.

As to the right to use any portion of that which belongs to the public, legislative control is applicable, and if, as a matter of fact, public rights are abused by the improper extraction of this public water by means of pumps, it is presumable that the Legislature in the exercise of its proper functions will in due time arrest such waste. The game of the state belongs to the people in their collective capacity in a more general way than does the subterranean water within an artesian belt, yet no one will question the right of the state to restrict the manner in which fish may be taken from the water, whereby it is made a public offense to use a seine, while those who adopt the hook and line may take without offense. There is no special privilege or immunity granted to the man with the hook and line. The right to take at all, or in any particular season, either of game or any other thing public in its character, comes from the state and is subject to its regulation and control, and it is for the Legislature to say what reasonable restrictions are necessary for the protection of this public property. Ex parte Kenneke, 136 Cal. 527, 69 Pac. 261, 89 Am. St. Rep. 177.

It is further contended that this act is violative of subdivision 33, sec. 25, art. 4, of the state Constitution, which provides that "the Legislature shall not pass local or special laws in any of the following enumerated cases, that is to say: . . . in all other cases where a general law can be made applicable"; and also violates section 11, art. 1, which provides that "all laws of a general nature shall have a uniform operation." Assuming all that the petitioner claims for the act as to its establishment of a class, nevertheless "the true practical limitation of the legislative power to classify is that the classification shall be based upon some apparent natural reason, some reason suggested by necesity, by such a difference in the situation and circumstances of the subjects placed in different classes as suggests the necessity or propriety of different legislation with respect to them." Nichols v. Walter, 37 Minn. 272, 33 N. W. 802. "A law which operates only upon a class of individuals is none the less a general law if the individuals to whom it is applicable constitute a class which requires legislation peculiar to itself, in the matter covered by the general law, and which is germane to the purpose of the law." People v. Central Pac. R. Co., 105 Cal. 576, 38 Pac. 905.

It is obvious that different legislation is required peculiar to those whose lands are so situated with reference to the artesian supply that a natural flow results from a penetration into the subterranean reservoir. The distinction between wells having a natural flow and those not so constituted is natural, and reasonably indicates the necessity or propriety of legislation restricting the former class. The right to so legislate when the reason exists is determined in Pasadena v. Stimson, 91 Cal. 251, 27 Pac. 604, People v. Central Pac. R. Co., 105 Cal. 576, 38 Pac. 905, and People v. Mullender, 132 Cal. 221, 64 Pac. 299. This act operates uniformly upon every one owning lands upon which is located an artesian well of the kind and character specified in the act. "Section 11, art. 1, of the state Constitution, requiring all laws of a general nature to have a uniform operation, is satisfied when the law operates uniformly upon all persons standing in the same category, and upon rights and things standing in the same relation." Wigmore v. Buell, 122 Cal. 144, 54 Pac. 600.

It is further contended that a discrimination exists because of the provision which permits the maintenance of ponds for the propagation of fish, as distinguished from the maintenance of ponds for other purposes. The propagation of fish has always been recognized as a legitimate pursuit and as an effort to increase the food supply of the world, and the use of water therefor a beneficial use, which, like the use for irrigation or domestic purposes, is declared by the act to be the highest use to which this natural element may be applied. The Legislature has the right to determine what uses are superior in kind and to protect the same, and it is within its province to determine that certain uses of this public property are of a higher character and superior in right to other uses. This right is subject only to the constitutional limitations against discriminations. Having so determined, and no just criticism being applicable thereto, the value of such uses must be held to be established.

We are not called upon in this case to determine the legislative right to regulate or protect the extraction of this subterranean water for transportation or sale of those owners of the surface whereon the use of water is not required for those higher uses, nor of prescriptive rights asserted or claimed in such instances, but simply to hold that for the uses which have been determined subordinate the great subterranean water supply may not be applied to the detriment of the higher uses, and that legislation directed to the conversation of such water, as in this act, is not prohibited by any constitutional provision. "Every possible presumption is in favor of the validity of a statute, and this continues until the contrary is shown beyond a rational doubt. One branch of the government cannot encroach on the domain of another without danger. The safety of our institutions depends in no small degree on a strict observance of this salutary rule." In re Spencer, 149 Cal. 400, 86 Pac. 896; Sinking Fund Cases, 99 U. S. 718, 25 L. Ed. 496.

Writ denied.

Book Notes.

The eighteenth edition of the "Western Blue Book and Buyers Reference." It is a volume of over 700 pages, giving the names and addresses of architects, engineers, contractors and parties interested in supplies for mills, mines, foundries, iron furnaces, steel mills, quarries, machine shops, railroads and other engineering industries. The names are classed in two ways. In the first part of the book those of Chicago parties are omitted and the rest are grouped by states; the names then subdivided according to calling or industry. In the second part of the book, all the Chicago names are classified alphabetically according to calling or industry. This list gives not only the street addresses, but also the telephone numbers. (Chicago, Milton E. Lowitz Publishing Co., 66 Sherman St., $5.)

A book that will appeal strongly to engineers who have had to live in wild districts is Lieut-Col. J. H. Patterson's "The Man-Eaters of

Tsavo." The author was one of the leading engineers of the famous Uganda Ry. in East Africa, a piece of work described in several articles in this journal. As explained in one of those articles, the railway work was completely stopped for a long period by the forays of lions, which terrorized the construction camps. At one station they carried off 28 coolies in a short time, and finally they took the assistant superintendent of police out of a first-class car on one of the sidings. For a while the men slept in trees, the station water-tanks and freight cars until lion-proof iron huts could be built for them. Every means to prevent their ravages or to kill them failed until Col. Patterson took charge of the work. The many thrilling adventures which he had before finally accomplishing the task make a unique story in the history of railway engineering. The author has also traveled in many other parts of wildest Africa and a section of the book describes some of his experiences elsewhere than on the Uganda line. (New York, Macmillan Co., $2.50.)

The third annual number of the "Beton-Kalender," for the year 1908, is 74 pages larger than the last issue of this excellent pocket-book and contains many new features. For those unacquainted with previous numbers it may be stated that the book is in two volumes, each about 4 x 6½ in. in size. The first volume is cloth-bound, and contains a diary and tables and articles relating to general statistics, money, weights and measures, mathematics, surveying, the strength of materials, cost of construction, the theory of reinforced concrete beams, various regulations regarding reinforced concrete construction, requirements for Portland cement and tests of the material and a digest of patent law. The second volume is bound in paper and contains articles on all kinds of works executed in concrete, with and without reinforcement. All the articles are written by specialists, and the book is edited by Dr. F. von Emperger, editor of "Beton und Eisen" and well known to American engineers on account of his former activity in introducing the Melan arch in this country. In addition to a complete revision of the different articles in the former edition, some of them have been completely rewritten, the latter relating to the cost of works, staircases, theatres, waterworks and sewerage. The official regulators include those of the Prussian and French governments of the current year. The book is invaluable to the concrete specialist who can read German. (Berlin, Wilhelm Ernst & Son, 4 marks.)

A valuable contribution to the records of American engineering is the two-volume "History of the Canal System of the State of New York, together with Brief Histories of the Canals of the United States and Canada," written by Mr. Noble E. Whitford and published as a supplement to the report for 1905 of the New York State Engineer. It is the first authoritative history of the first important engineering undertaking in this country, which began in 1793 with the construction of a small canal at Little Falls and is still being continued. The work was the training school of our first engineers and of many of the men of succeeding generations who followed them in important positions in the national life, as is well shown by an interesting collection of brief biographies of those who held the rank of assistant engineer or higher. The preparation of the history became necessary in connection with the work of the State Engineer's Department, and it is fortunate that Mr. Whitford was assigned to the work, for along with a knowledge of engineering subjects he has shown excellent judgment in the references to historical topics forming an essential part of his narrative. It is a most instructive record of engineering achievement, covering not only the existing canals, but also the abandoned canals, the canals built by private parties, and general studies of the effect of the canals on some features of State life, particularly the development of communities along the line of the Erie canal. The second volume contains engineering and financial statistics of the State canals, a bibliography of them, and a description of all the leading canals of the world.

It is not often that a reviewer of technical books has an opportunity to draw attention to a work which so well answers a very strong demand as does the "Principles of Reinforced Concrete Construction" by Professors F. E. Turneaure and E. R. Maurer, of the University of Wisconsin. Up to the present time there has been no American book which discussed reinforced concrete with the same authoritative thoroughness as Mr. Sabin goes over the subject of plain concrete in his treatise on "Cement and Concrete." While there have been a number of volumes on reinforced concrete none has answered the great demand for a thorough discussion of principles, for a large part of each of them is devoted to descriptions of structures and of methods of carrying on construction, already available in greater detail in the pages of the many journals devoting all or part of their space to concrete. The authors of this volume have followed the plan of covering in a systematic manner at the outset those principles of mechanics underlying the design of reinforced concrete, then bringing together the results of all available tests that may aid in establishing reliable coefficients and working stresses, and finally giving such information concerning actual designs as may be needed to make clear the principles involved. The properties of plain concrete and steel are explained sufficiently in the second chapter to give definite knowledge of their relation to the general subject in hand, and adhesion, contraction and expansion are discussed. The third chapter is a full theoretical treatment of reinforced concrete, in which empirical rules and methods are avoided so far as possible in order that the reader may acquire such a firm grasp of the real principles that he may appreciate the nature and effect of any approximate methods brought to his attention. The fourth chapter supplements the third by reviewing, in the light of the previous theoretical study, the results of the most important tests of beams and columns. Working stresses and economical proportions are taken up in the fifth chapter. The sixth chapter is an excellent practical summary of working formulas, diagrams and tables for use in designing beams, slabs and columns, so arranged that they can be employed without reference to any other part of the book. These six chapters take up 236 pages, and are followed by 77 pages explaining the application of reinforced concrete to building construction, arches, retaining walls, dams and miscellaneous structures. These chapters explain principles of design rather than details of construction and thus furnish just the information which is necessarily omitted in articles in technical journals. Special attention should be given to the authors' analysis of the solid arch rib, which they consider superior to the ordinary graphical methods, and may be shortened by simple graphical aids. The rather hasty examination on which these notes regarding the book are based shows it to be a conservative, safe guide. There are some things in it to which The Engineering Record does not agree, but these are things where differences of opinion will always exist. The authors are always on the safe side and the volume they have prepared deserves a warm welcome and thorough study. (New York, John Wiley & Sons, $3.)

Letters to the Editor.

Traffic on New York Streets.

Sir: Duirng the examination made by the Commissioners of Accounts of New York City of the administration of the pavements, etc., of Manhattan, and subsequent investigation by Governor Charles E. Hughes of New York State, it became necessary to know the quantity of traffic on representative avenues and streets. I was employed as consulting engineer on pavements, and among other matters reported to the Governor the traffic on several streets and showed its relation to the maintenance or neglect of the pavements. The heavy traffic streets in wealthy and influential districts, as Fifth Ave., are maintained in good order, whereas the lighter traffic streets in poor districts have not been kept in repair. Traffic records have heretofore been made for 10, 11 or 12 daylight hours. Therefore for purposes of comparison with previous traffic, I made records for 11 daylight hours on various streets. The heaviest traffic recorded in New York for 11 hours was on Oct. 14, 1907. It was 11,170 vehicles, weighing about 13,360 tons, on Fifth Ave. between 33d and 34th Sts., or 279 vehicles, or 324 tons, per foot of width of roadway for 11 hours. The traffic on First Ave. between 26th and 27th Sts. for 11 hours on the same date was 4,445 vehicles, weighing about 6,734 tons, which was about 79 vehicles, or 120 tons, per foot of width of roadway for 11 hours.

The accompanying tables show the traffic on Fifth and First Aves. for 24 consecutive hours. This is probably the first time that traffic for 24 hours has been recorded in any American city.

Vehicles in 24 Hours on Fifth Avenue, New York, Between 58th and 50th Streets. From Wednesday Noon, Oct 9, to Thursday Noon, Oct 10, 1907.

Hours.	Horse Vehicles. Av. Weight with Load. 1 ton.	2 tons.	4 tons.	Total Horse Vehicles.	Automobiles, Av. Wgt. 1 ton.	Total Vehicles.
12-1	437	69	30	536	230	766
1-2	421	107	20	548	184	732
2-3	296	60	11	367	142	509
3-4	583	86	24	693	331	1,024
4-5	661	88	17	766	400	1,166
5-6	537	42	9	588	329	917
6-7	484	46	1	531	275	806
7-8	156	60	3	219	115	334
8-9	165	37	3	205	54	259
9-10	122	12	0	134	75	209
10-11	119	9	0	128	70	198
11-12	117	13	0	130	71	201
Midnight	...	...	...	...	...	...
12-1	85	27	0	112	45	157
1-2	40	8	0	48	20	68
2-3	14	6	2	22	5	27
3-4	21	2	3	26	4	30
4-5	33	14	6	53	3	56
5-6	27	19	24	70	0	70
6-7	42	44	2	88	19	107
7-8	122	57	12	191	31	222
8-9	211	53	6	270	187	457
9-10	263	51	19	333	179	512
10-11	437	51	17	505	308	813
11-12	432	65	10	507	232	739
Totals	5,825	1,026	219	7,010	3,309	10,379

The estimated weight of Fifth Ave. vehicles and loads was 12,062 tons. The width of Fifth Ave. at the place of recording this traffic is 41⅓ ft. There were therefore 251 vehicles, or 292 tons, per foot of width per 24 hours. This can be regarded as an average weekday traffic on Fifth Ave. between 9th and 59th Sts. The Sunday traffic on Fifth Ave. is about one-fifth the weekday traffic.

The estimated weight of First Ave. vehicles and loads was 3,898 tons. The width of First Ave. at the place of recording this traffic is 56 ft. There were therefore 48 vehicles, or 69⅔ tons, per foot of width per 24 hours. This can be regarded as an average weekday traffic on First Ave. between 22d and 109th Sts. The Sunday traffic on First Ave. is very small; sometimes none is in sight for an hour or more.

Fifth Avenue, New York, has probably the most numerous, if not the heaviest traffic in total quantity, as well as per foot of width, found in any American city. It is exceeded by a few streets in Paris, London and Berlin. It is interesting to note the large proportion of automobiles now in use.

VEHICLES IN 24 HOURS ON FIRST AVENUE, NEW YORK, BETWEEN 77TH AND 78TH STREETS. FROM WEDNESDAY NOON, OCT 9, TO THURSDAY NOON, OCT 10, 1907.

Hours.	Horse Vehicles Av. Weight with Load. 1 ton.	2 tons.	4 tons.	Total Horse Vehicles.	Automobiles, Av. Wgt. 1 ton.	Total Vehicles.
12-1	96	44	3	143	1	144
1-2	165	45	6	216	0	216
2-3	183	60	13	256	3	259
3-4	149	73	9	231	3	234
4-5	108	80	7	195	0	195
5-6	104	91	4	199	2	201
6-7	83	42	2	127	1	128
7-8	41	22	1	64	0	64
8-9	33	11	0	44	0	44
9-10	19	7	0	26	0	26
10-11	3	5	0	8	0	8
11-12	3	3	1	7	0	7
Midnight	...	...	...	...	...	...
12-1	0	0	0	0	0	0
1-2	1	0	0	1	0	1
2-3	4	2	2	8	0	8
3-4	14	10	1	25	0	25
4-5	16	5	1	22	0	22
5-6	45	10	1	56	0	56
6-7	58	41	4	103	0	103
7-8	95	24	12	131	1	132
8-9	102	58	20	180	0	180
9-10	134	52	23	209	1	210
10-11	129	71	20	220	3	223
11-12	116	48	13	177	2	179
Totals	1,701	804	142	2,648	17	2,665

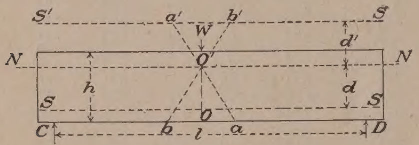
Records of street traffic help solve the paving problems of cities and should be made at reasonable intervals in every important city. The flow of traffic needs controlling, guiding and relief, not only on account of pavements but for other obvious reasons. J. W. HOWARD, C. E., E. M.

1 Broadway, New York.

THE DEFLECTION OF CONCRETE BEAMS.

SIR: In my work recently I was asked to compute the deflection of a reinforced concrete beam under a certain loading. As I have never seen any method for making this computation, it may be of interest to some of your readers to know of one which is at least correct for the assumption that the concrete takes only compression.

Given a concrete beam as shown in the diagram, reinforced with steel *SS* and having a concentrated load *W* applied at the center between the supports *C* and *D*, it is required to find the deflection of the beam at the point *O* due to the load *W*.



Knowing the amount of steel and *h*, the distance of the steel reinforcement from the top of the beam, the neutral axis *NN* can be located. For an infinitesimal length, Δ *l*, *ba* represents the elongation of the steel and *ef* the contraction in the concrete after the application of the load *W*. If we replace the concrete compression side of the beam by a steel member S^1S^1 of the same area as *SS* and so placed as to maintain the neutral axis at *NN*, and if we properly increase *W* so as to produce the same stress, and hence deformation, in the steel *SS* for this hypothetical beam as for the reinforced concrete beam, we shall have a beam whose deflection can be readily calculated and will be the same as that of the original beam.

To do this make $d^1 = d$ and increase *W* by the ratio, (moment of resistance of hypothetical steel beam) to (moment of resistance of reinforced concrete beam). The moment of resistance of the hypothetical steel beam is $2d$(area of *S S*) (stress per square inch). The moment of resistance of the reinforced concrete beam is (area of *SS*) (stress per square inch) $(d + \frac{2}{3}k)$.

Hence $2d\,W \div (d + \frac{2}{3}k)$ is the load that will give the required deflection of the hypothetical beam. The required deflection is, therefore, readily obtained from the familiar formula for the deflection of a beam of uniform material and is given by the expression

$$[2d\,Wl^3 \div (d + \tfrac{2}{3}k)] \div 48\,EI.$$

In this expression I *is* $2d^2$ (area of *SS*).

Hoping that this may be of some interest, I am,

Yours sincerely,

ELI WHITE.

New York, Oct. 21.

HEATING AND VENTILATING TESTS.

SIR: As your recent editorial under the above title clearly shows, there is certainly a fertile field, as yet almost untilled, for the investigation of the present practice in heating and ventilation. But the problem in its entirety is exceedingly complicated, for the heating and the ventilation are interdependent. In any system the variables are so numerous as to greatly increase the difficulties. Attention must therefore be centered upon details and the engineering structure built up therefrom.

In any modern system of reasonable magnitude the fan will be found as a relatively positive factor in the movement of the air. As a basis for further investigations of complete systems, it appears that the fan should first receive consideration.

Almost without exception the manufacturers' ratings and incidental guarantees have been heretofore accepted as the measure of performance. Because of the great flexibility of the fan as regards possible changes in speed, volume, pressure and power, established conditions have been difficult to maintain, and hence departure from the results shown by the standard basis of measurement was to be expected.

Tests sufficient to meet commercial requirements in engineering and selling have been made by manufacturers and individual engineers, but, as your editorial suggests, the results have been kept secret and retained as personal stock in trade. In a rough way the information thus collected has appeared to serve the purpose. The failure of the purchaser to demand test before acceptance, and in reality, the lack of real necessity for such a test, have had much to do with the continuance of this policy. But the time is now at hand when methods of testing should be standardized; when exhaustive tests should be made, and the results become public property. The age of secrecy is passed; the leader in disseminating knowledge of this character may likewise be the leader in the commercial field.

For years the comparison of fans upon their capacity areas has been prevalent. That is, for each and every cased fan, with little consideration of its proportions or speed, it has been assumed that this capacity area was equal to one-third of the product of the diameter and the width of the wheel at its periphery. This area has represented the maximum over which maximum velocity and pressure could be maintained. In point of fact it varies with the width of the wheel, the number and curvature of its blades, and the proportion of its casing; it is influenced by the speed, and by the presence of one or two inlets.

Although to a limited degree the general effect of these variables is known to some manufacturers and engineers, there is no well defined public or private knowledge upon the subject. Even the best method of testing the independent blower is far from established or approved. The old-time method consists in providing the standard outlet in the casing with a tapering pipe, reduced at its end to an effective area equal to the capacity area as above described, and then taking pressure measurements by a single water gauge. Velocities, if low enough, were measured by the anemometer, which, however, was seldom accurately calibrated. If too high for the anemometer, they were calculated from the total pressure.

The tests on ventilating fans conducted a few years ago by Mr. D. W. Taylor probably represent the greatest accuracy in methods, instruments and measurements. They have been made public in "Transactions" of the Society of Naval Architects and Marine Engineers, but unfortunately not in a form to be essentially valuable to the average man. The Pitot tube was used with great care, and tests conducted upon numerous relatively small standard fans discharging through extended lengths of straight piping. But no general comparison of types and proportions of fans was made.

Tests made under either of the two preceding methods are concerned directly with the creation and measurement of pressure and velocity within the pipe.

An entirely different method consists in discharging the air into a large, air-tight chamber against a known maintained resistance, the practical extinction of the velocity therein, and its re-creation when the air is allowed to escape through an opening out of the line of direct discharge from the fan.

Results based upon the first method lead one to think in terms of the pressure produced by the fan to overcome resistance; the second brings first to mind the resistance to be overcome as a factor in determining the volume which a given fan may be able to deliver.

Between these, and possible other methods of testing, some choice should finally prevail in the engineering world as a fundamental basis for determining the performance of a fan. The relations and influences of static and dynamic pressures should be clearly understood. The proper methods, the proper instruments, and the proper calibration should be likewise established and figured.

Much of this work, particularly in the preliminary stages and in isolated detail, appears to lie peculiarly within the province of the technical school. Unity of purpose and concerted effort on the part of the leading schools would, through investigation for thesis and similar work, soon add materially to the fundamental knowledge we so much need. Aside from the general interest which any school should properly take in the matter, the existence of courses in heating and ventilation in many of the leading schools should furnish a reason for conducting the tests. It cannot be doubted but that broad-minded manufacturers would readily co-operate in any such effort.

Anything that would remove the present confusion in published or private tables of fan performance, and which would establish standard results for typical forms, would be a distinct gain to all concerned.

In the field of the disc and propeller fan, which is distinct in principle from the centrifugal type just under consideration, there is room for excellent work.

As a foundation for any series of investigations in fan performance, a reliable bibliography would be of inestimable value. Through society transactions, engineering periodicals, text-books, and the like, there is scattered much of real value. Unfortunately there is an excess of the unreliable, which should be carefully eliminated. A careful consideration of the residuum would avoid much duplication of effort, and clear the way for effective work. In all of this it appears that the technical school could play an effective part; the most vital results could be published in the name of the professors under whom the work was conducted, and who were generally responsible for its accuracy.

Manifestly a body like the American Society of Heating and Ventilating Engineers should be deeply interested in the subject. It has already done much to awaken interest, and promote investigation. Concerted, combined, systematized effort would bring eventual returns of great value.

Boston, Oct. 31. WALTER B. SNOW.